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United States of America

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GB 2374098 A EP 1555386 A1
WO 2003/029608 A1 WO 2000/037766 A2

(58) Field of Search:
INT CL[7] E21B
Other: EPODOC, JAPIO, WPI, TXTE (FULLTEXT)

(54) Abstract Title: **Mono diameter wellbore casing**

(57) An apparatus 200 for radially expanding and plastically deforming an expandable tubular member 12 comprising: a support member 14, a first expansion device 206 for radially expanding and plastically deforming the tubular member coupled to the support member; and a second expansion device 202 for radially expanding and plastically deforming the tubular member coupled to the support member. A gripping or locking device 16, which may have slips or dogs for engaging the tubular member 12, is also coupled to the support member 14.

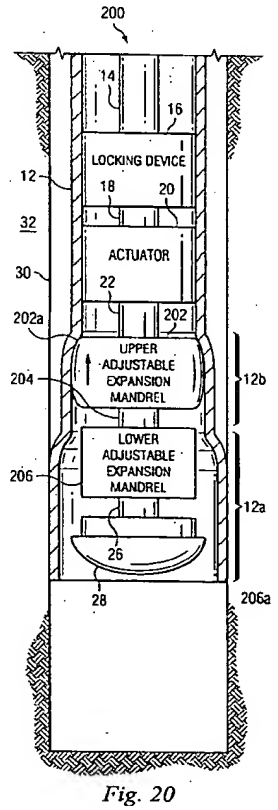

Fig. 20

GB 2 421 259 A

GB 2421259 A continuation

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Kevin Karl Waddell

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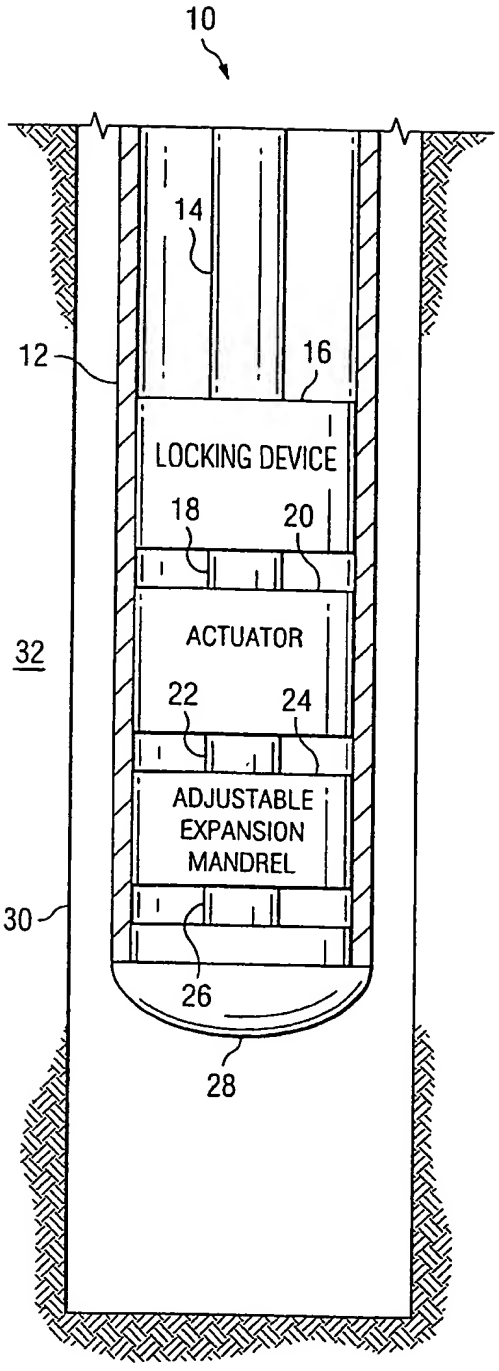
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Fig. 1

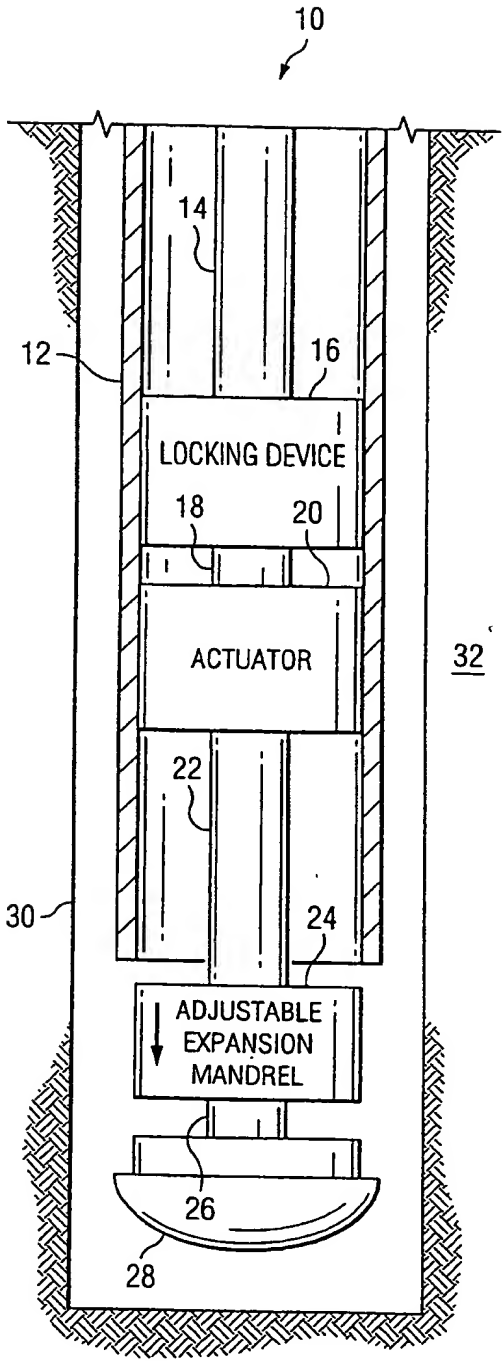
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Fig. 2

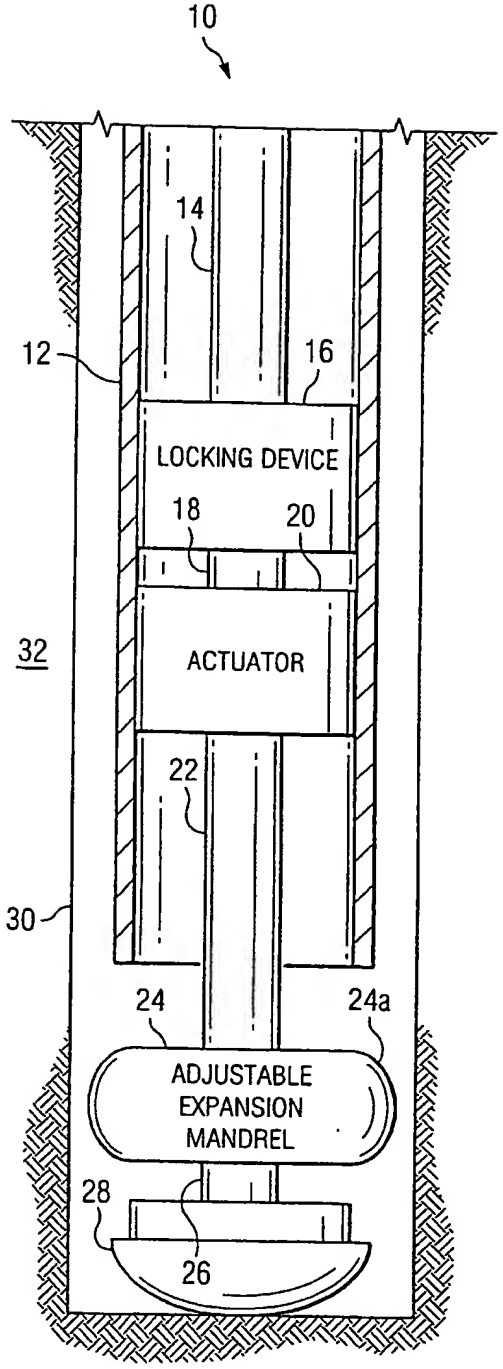
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Fig. 3

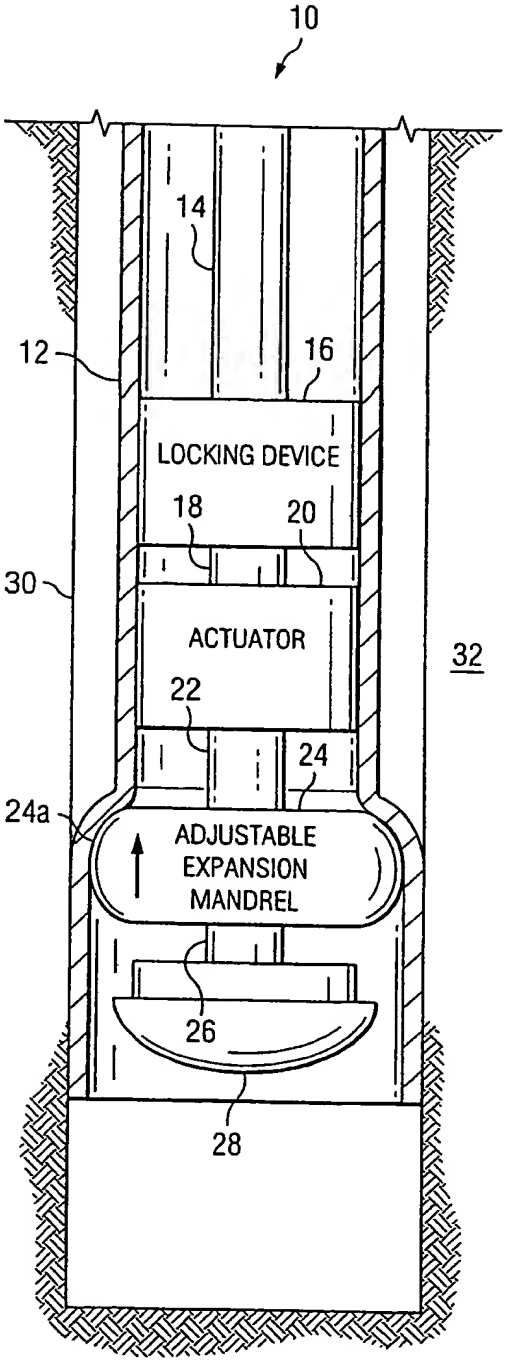
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Fig. 4

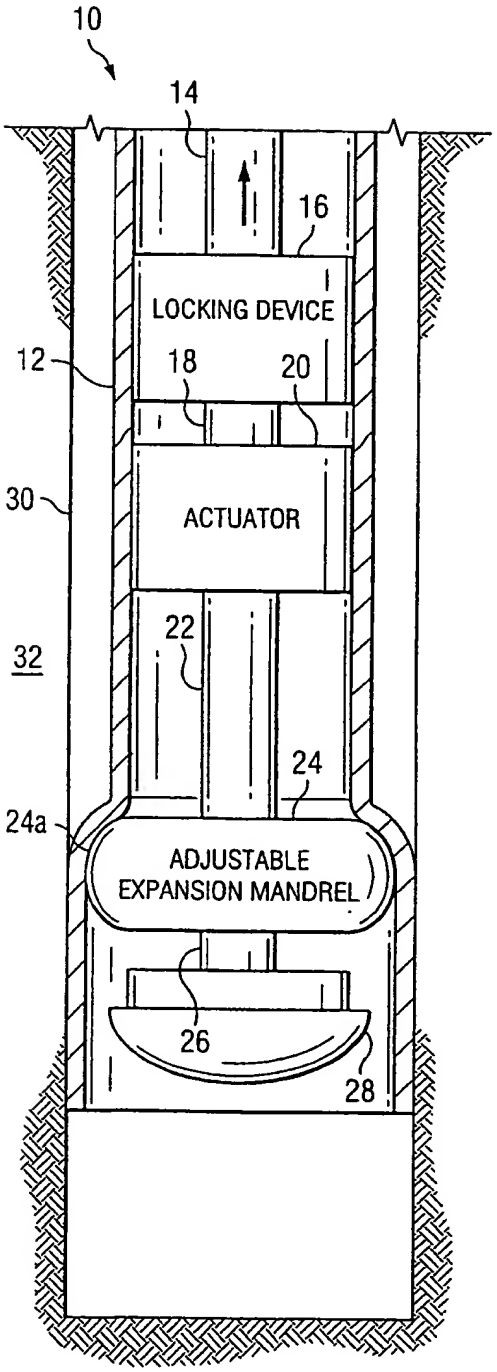
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Fig. 5

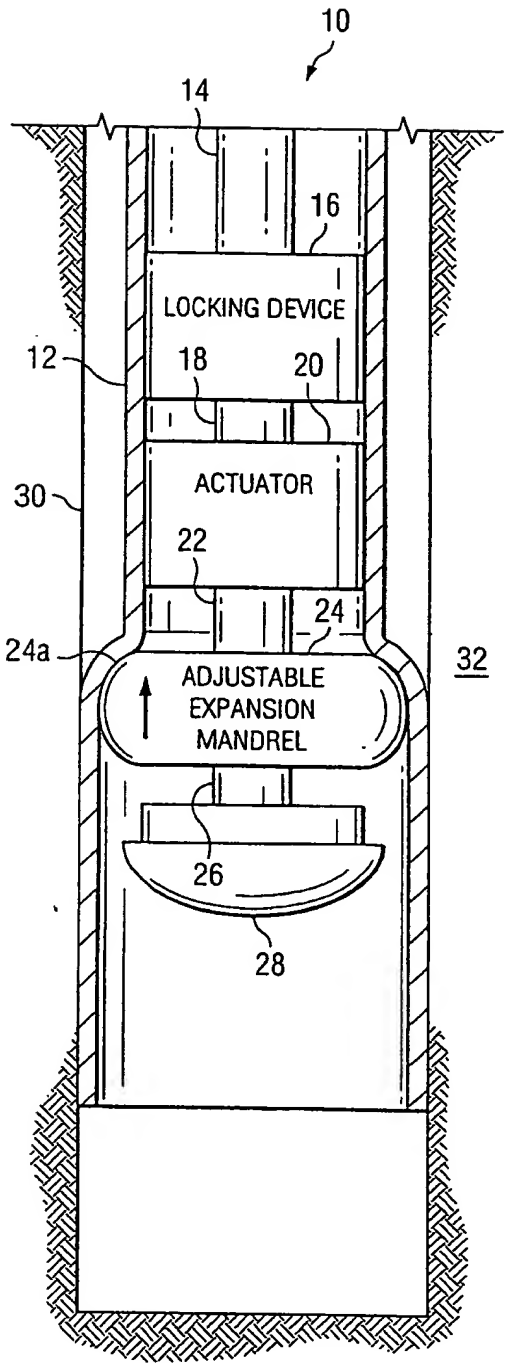
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Fig. 6

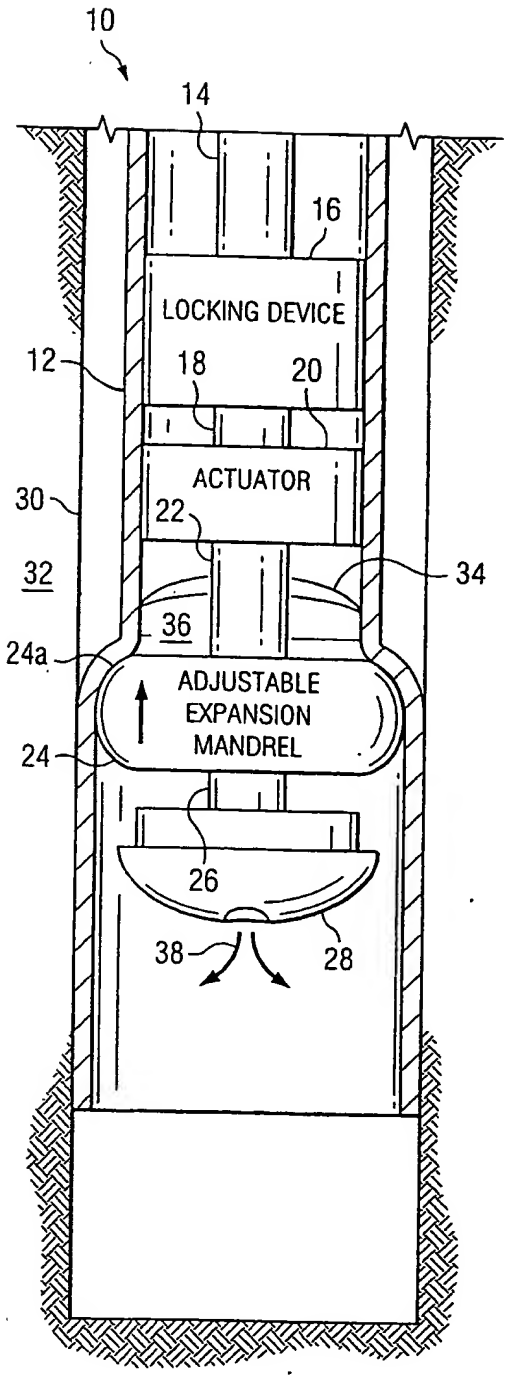
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Fig. 6a

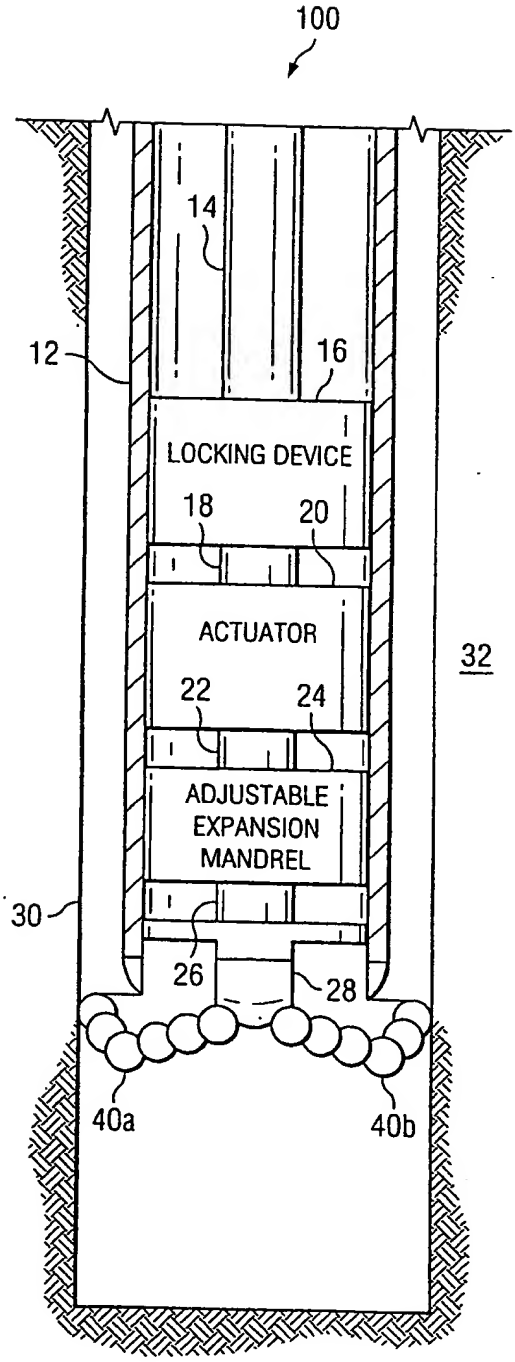
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Fig. 7

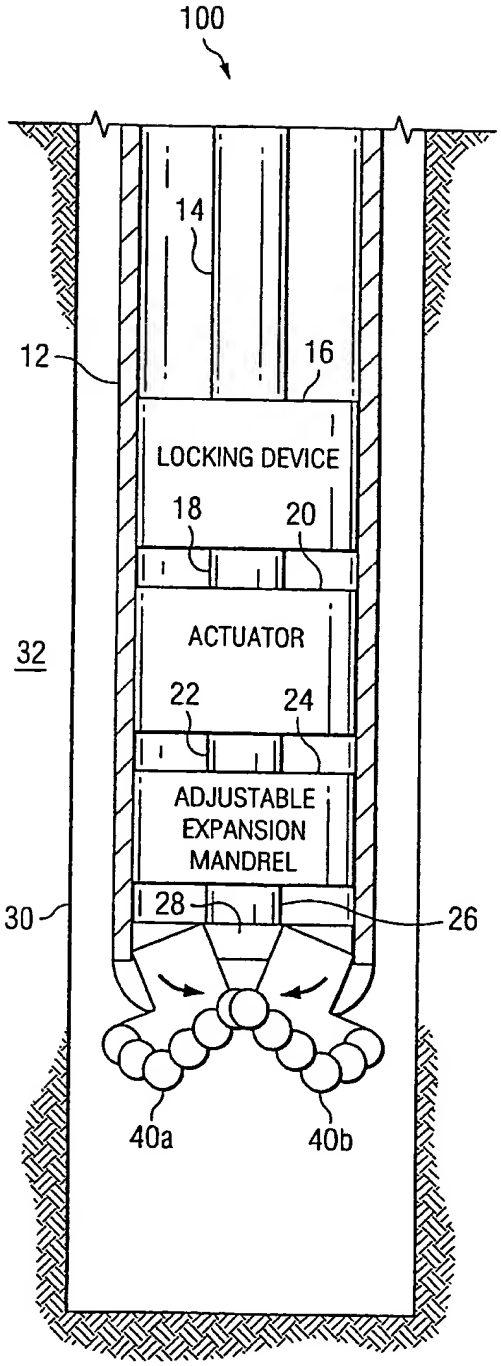
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Fig. 8

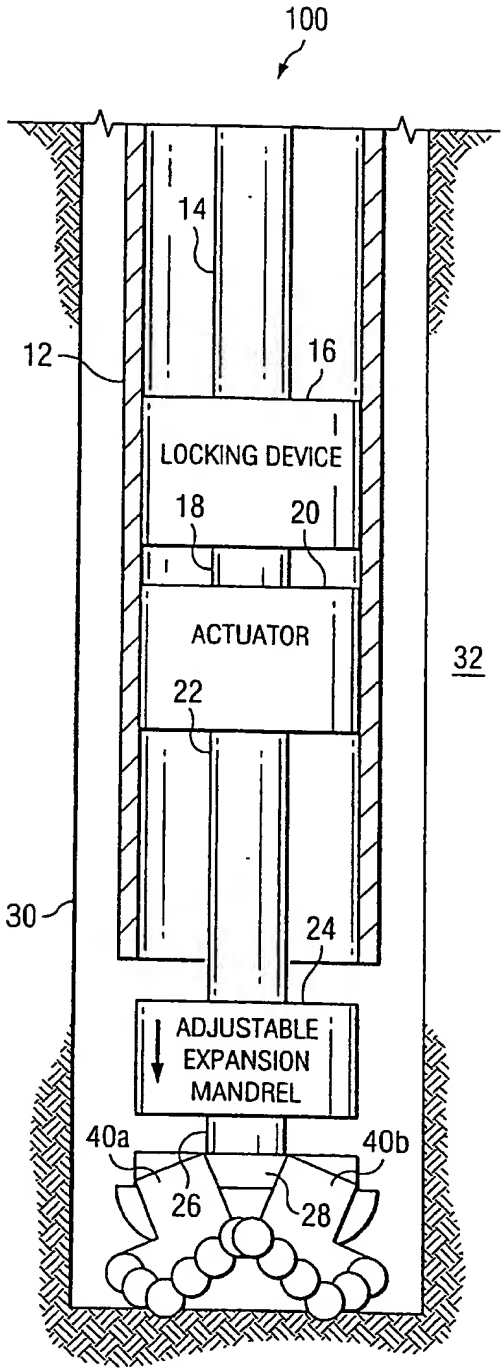
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Fig. 9

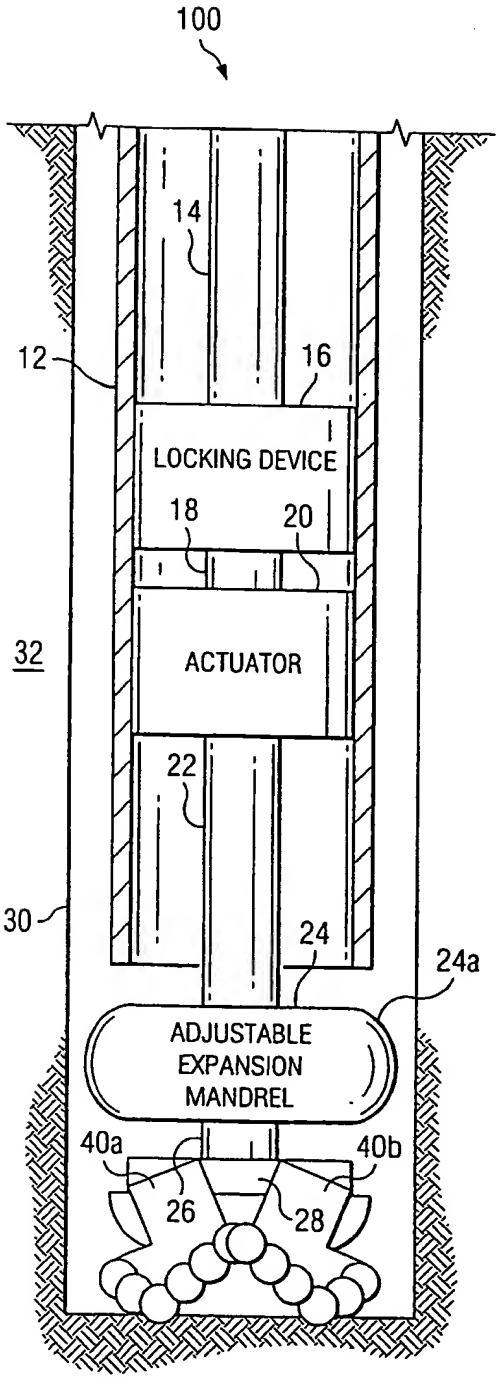
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Fig. 10

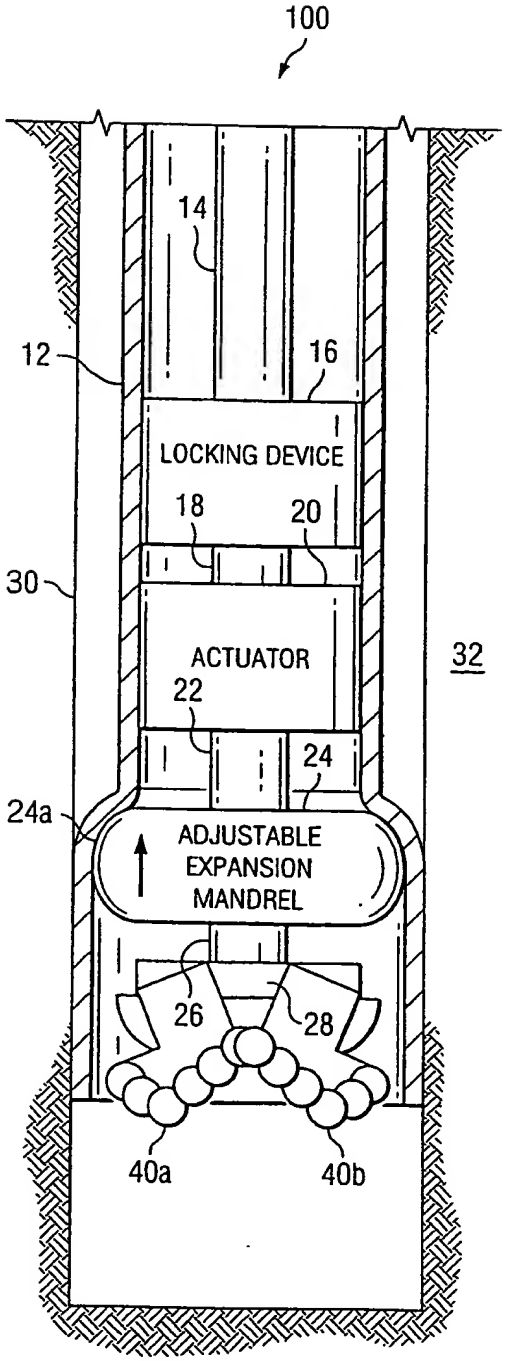
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Fig. 11

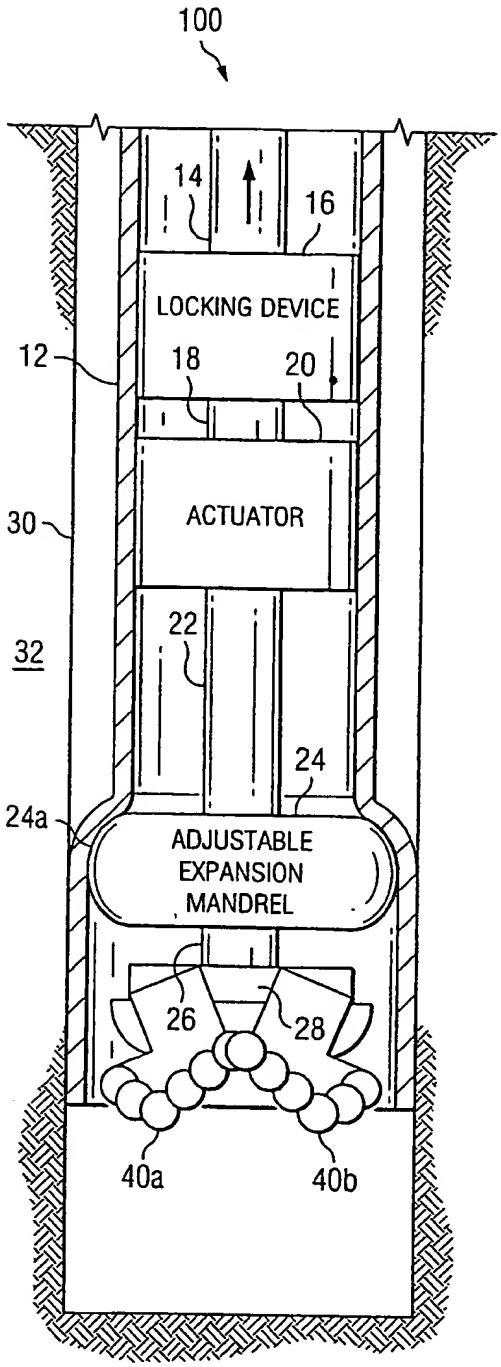
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Fig. 12

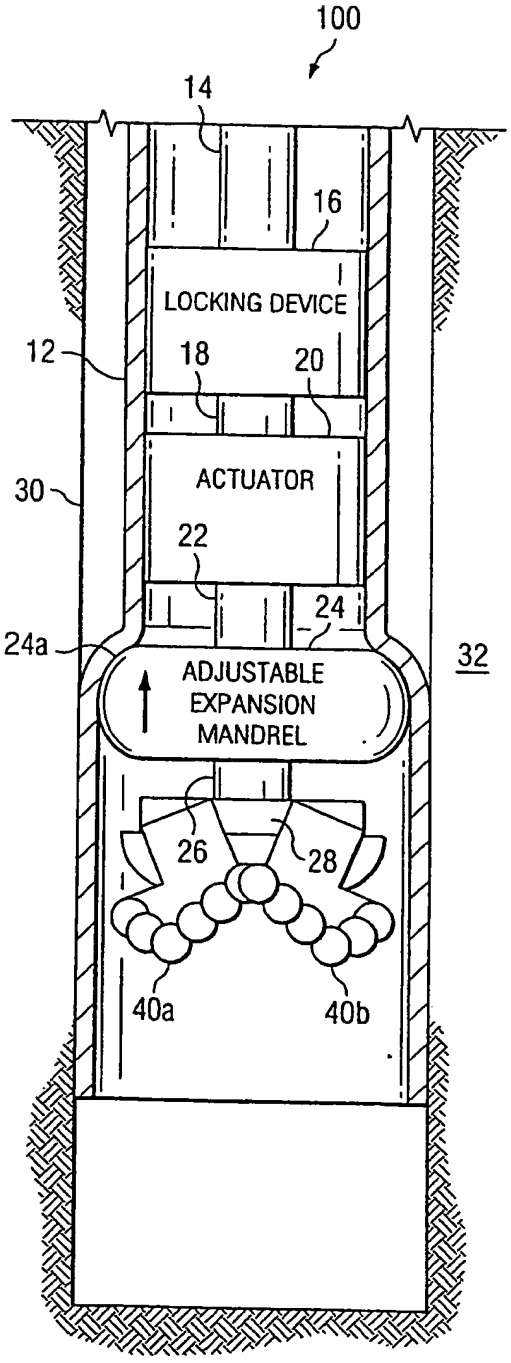
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Fig. 13

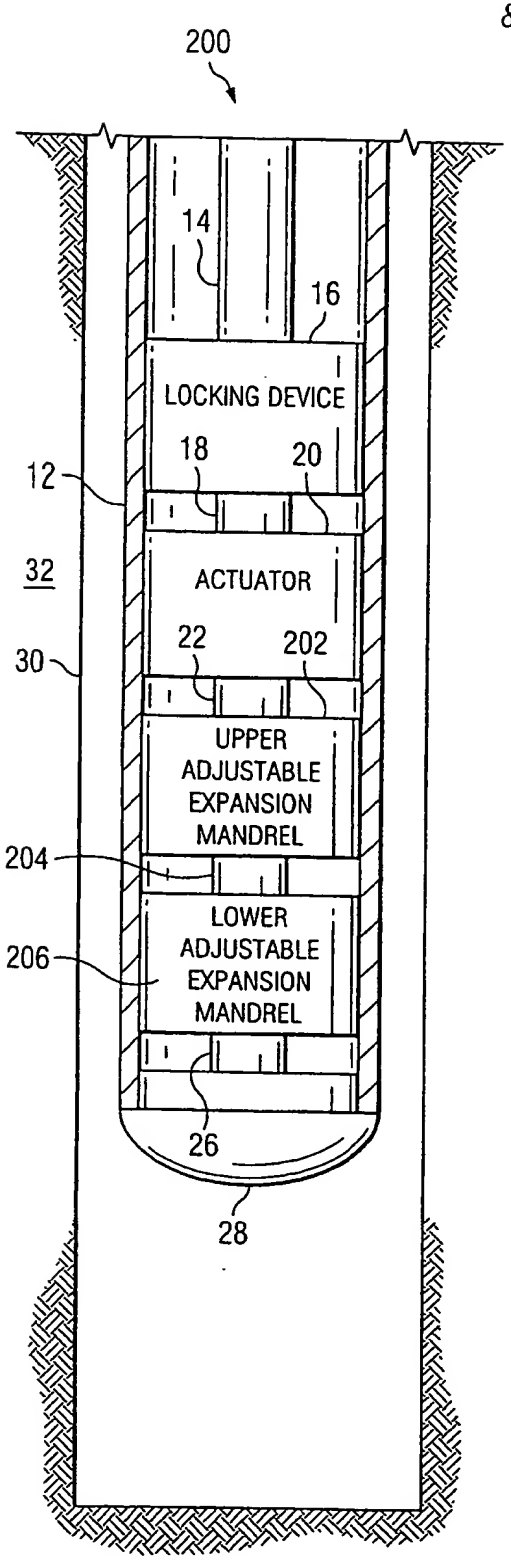
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Fig. 14

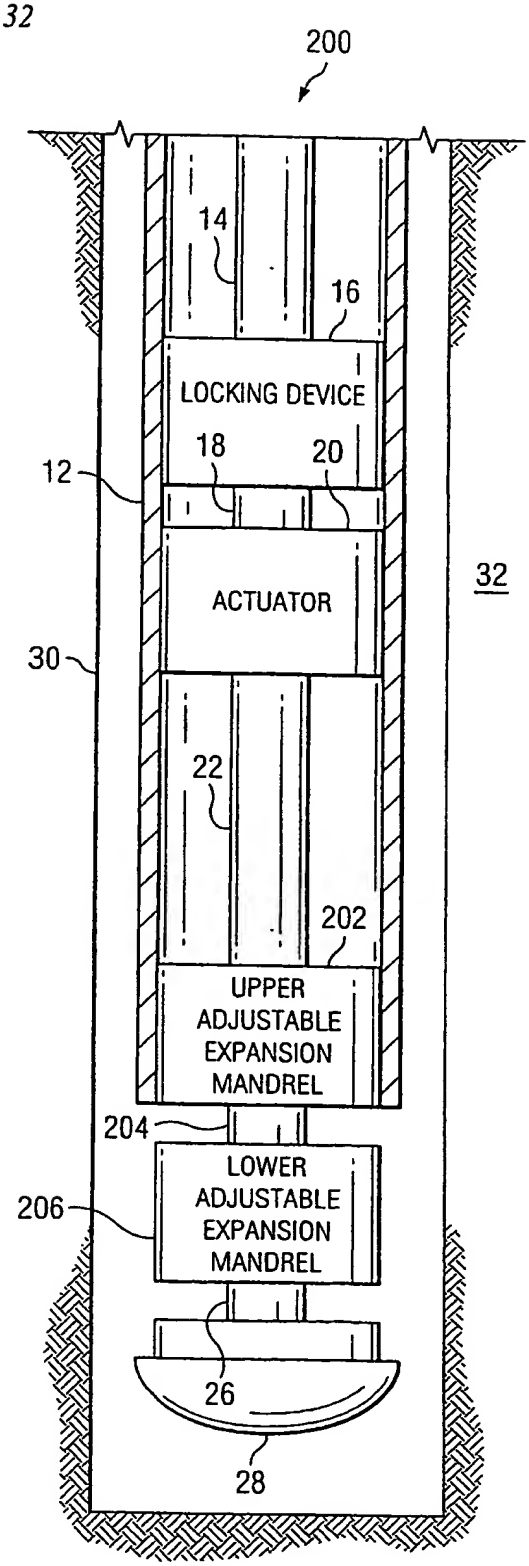
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Fig. 15

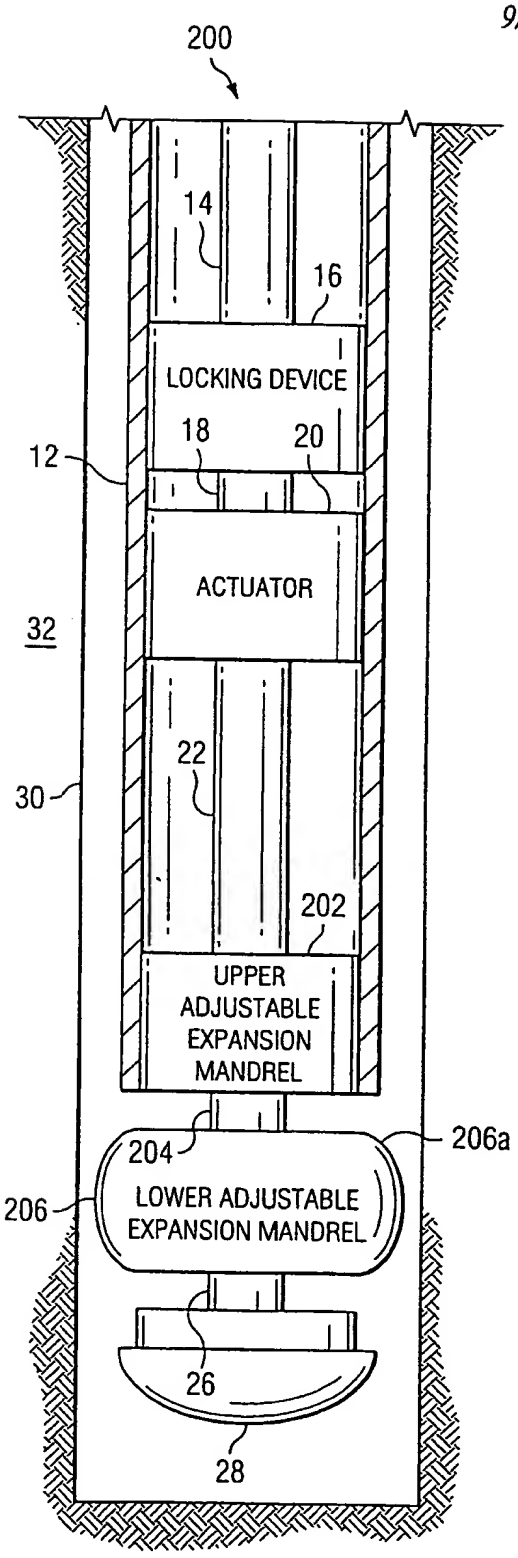
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Fig. 16

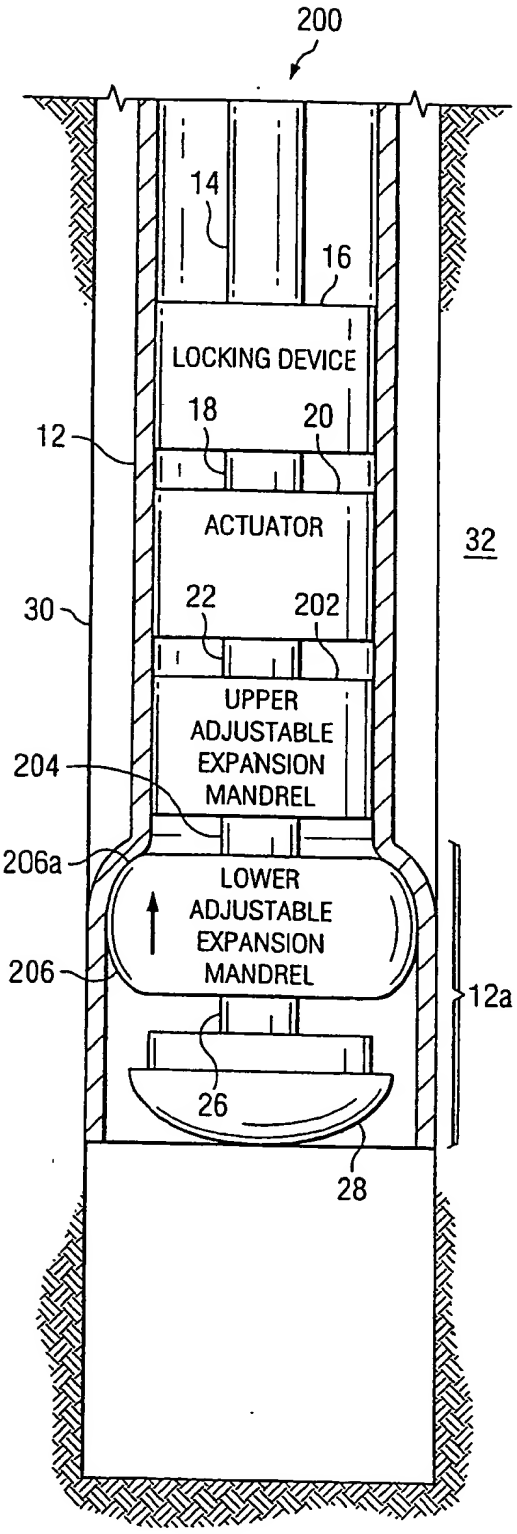
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Fig. 17

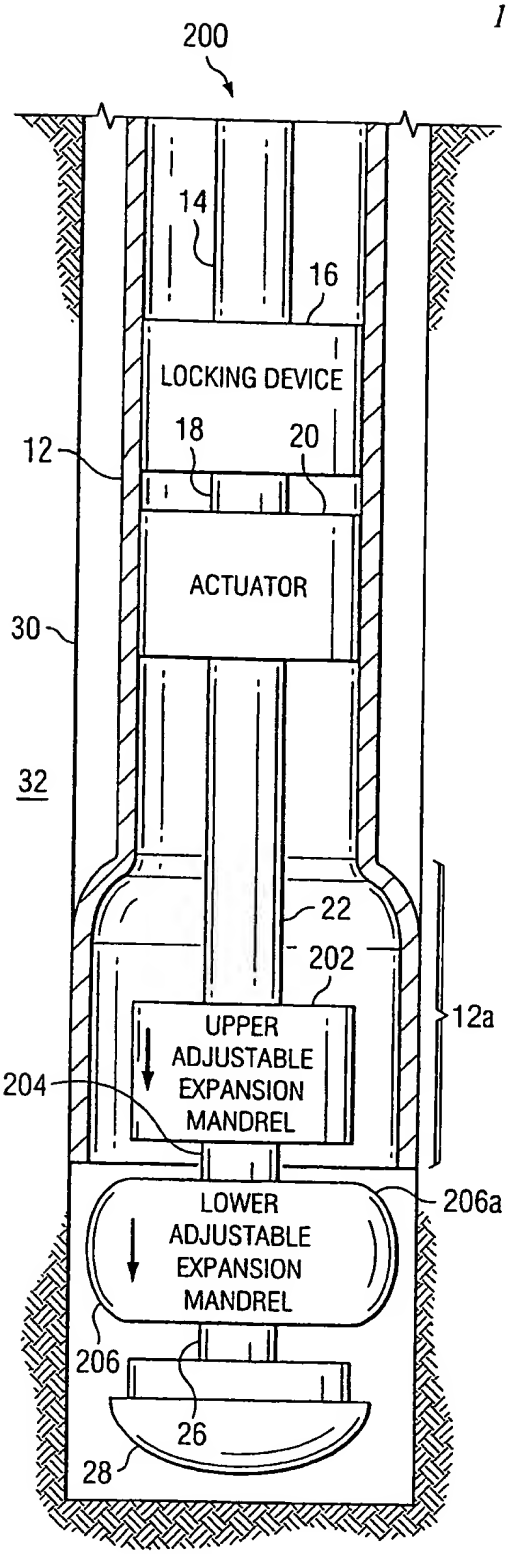
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Fig. 18

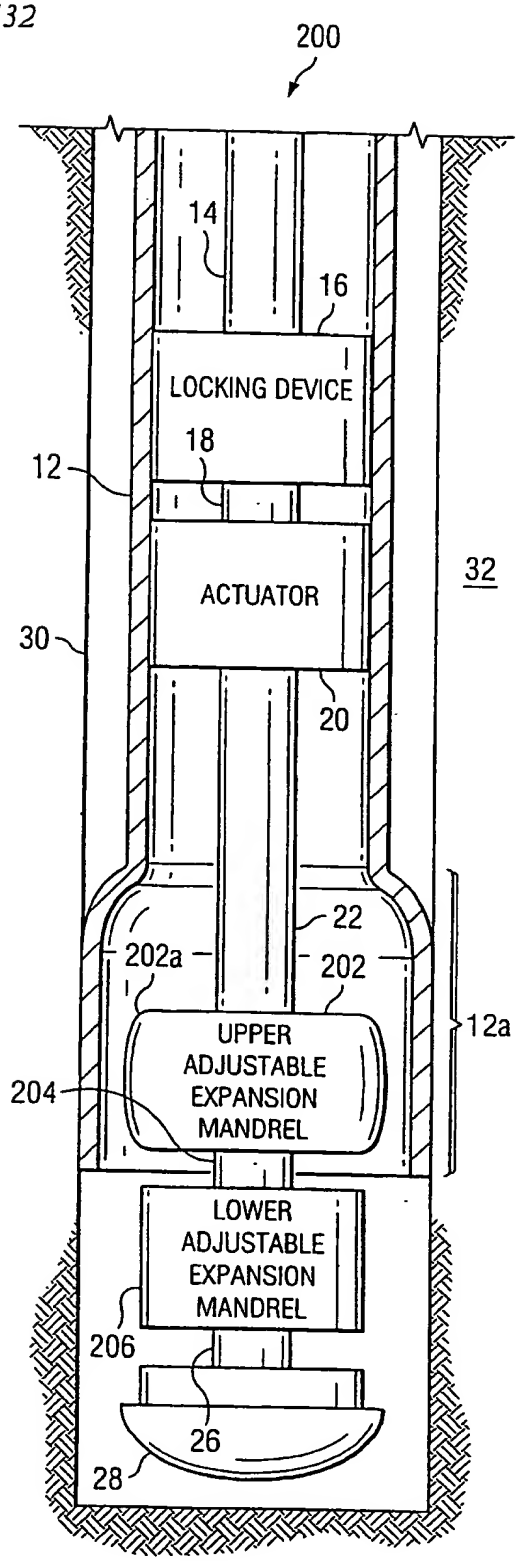
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Fig. 19

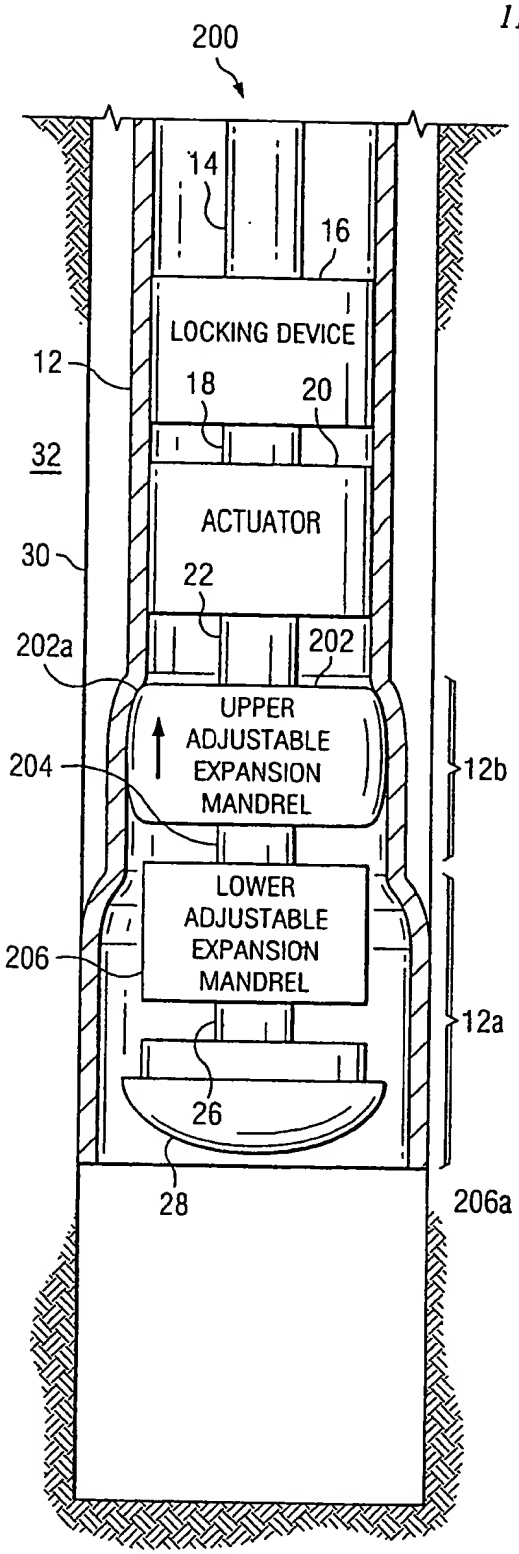
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Fig. 20

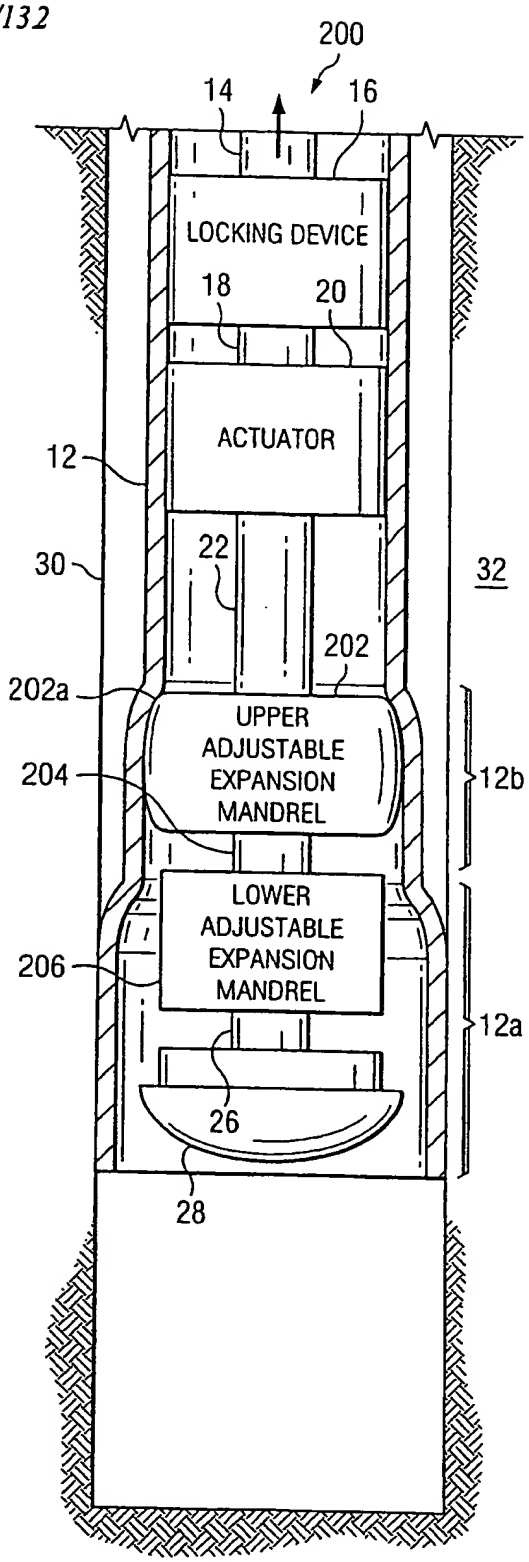
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Fig. 21

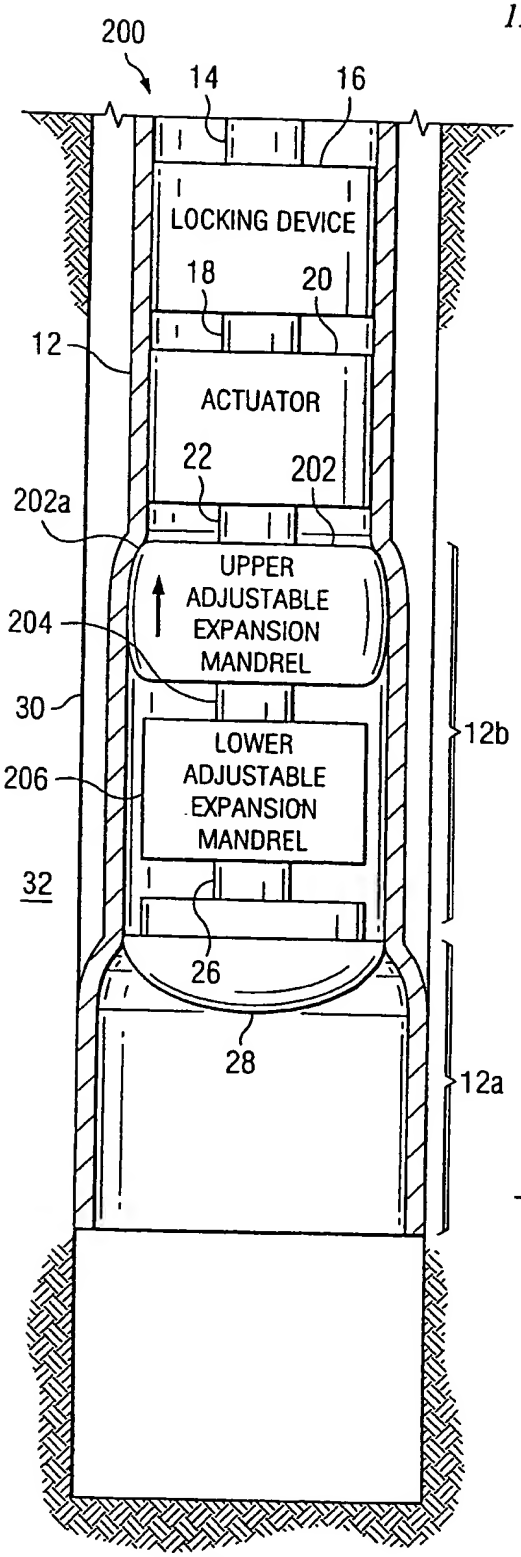
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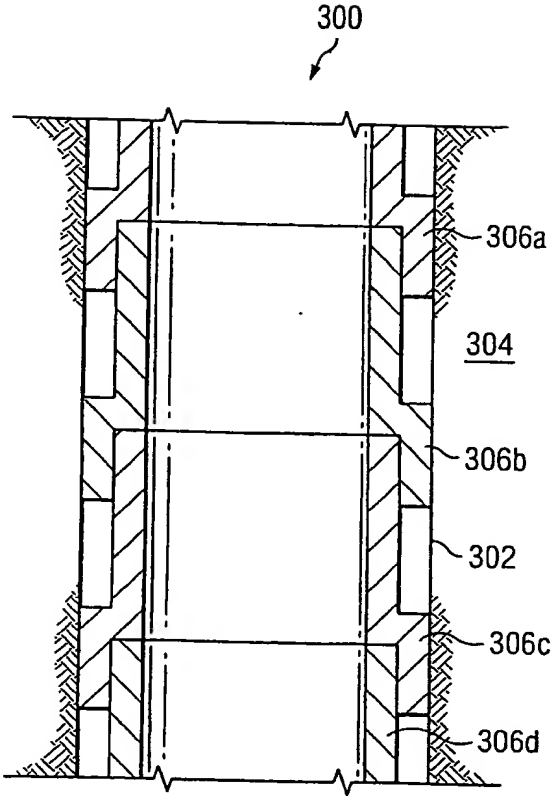
Fig. 22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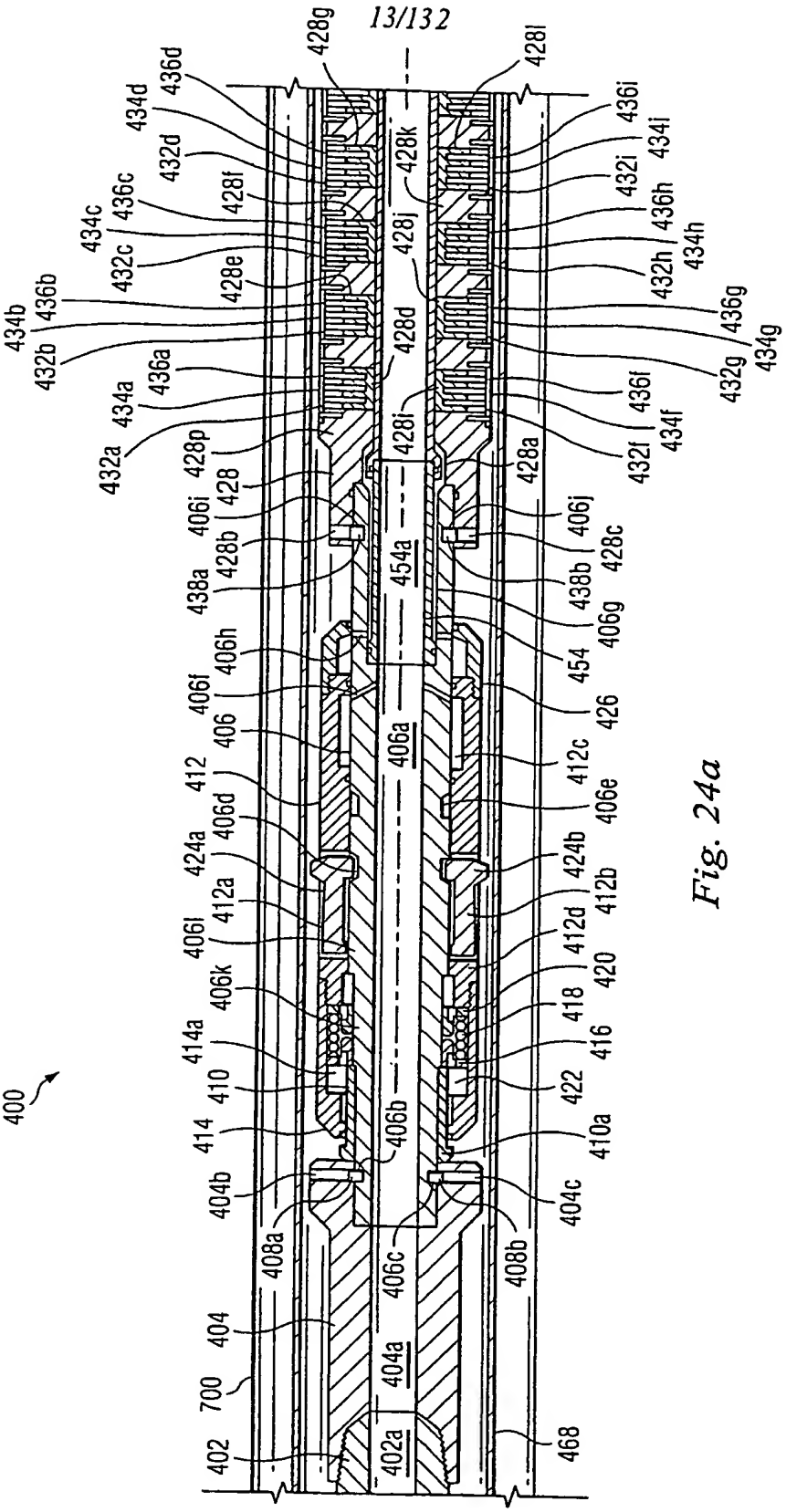
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Fig. 24a

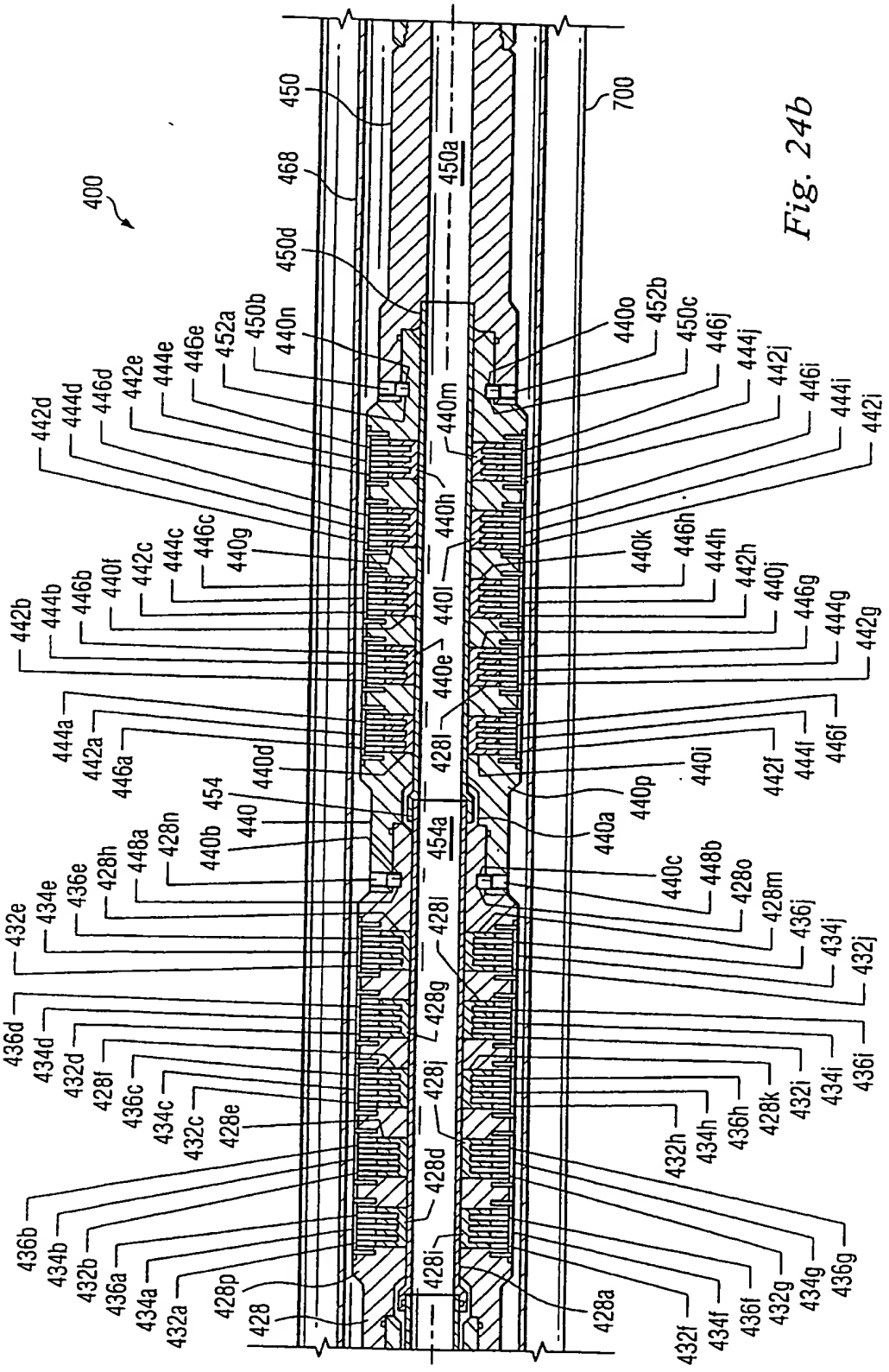
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Fig. 24b

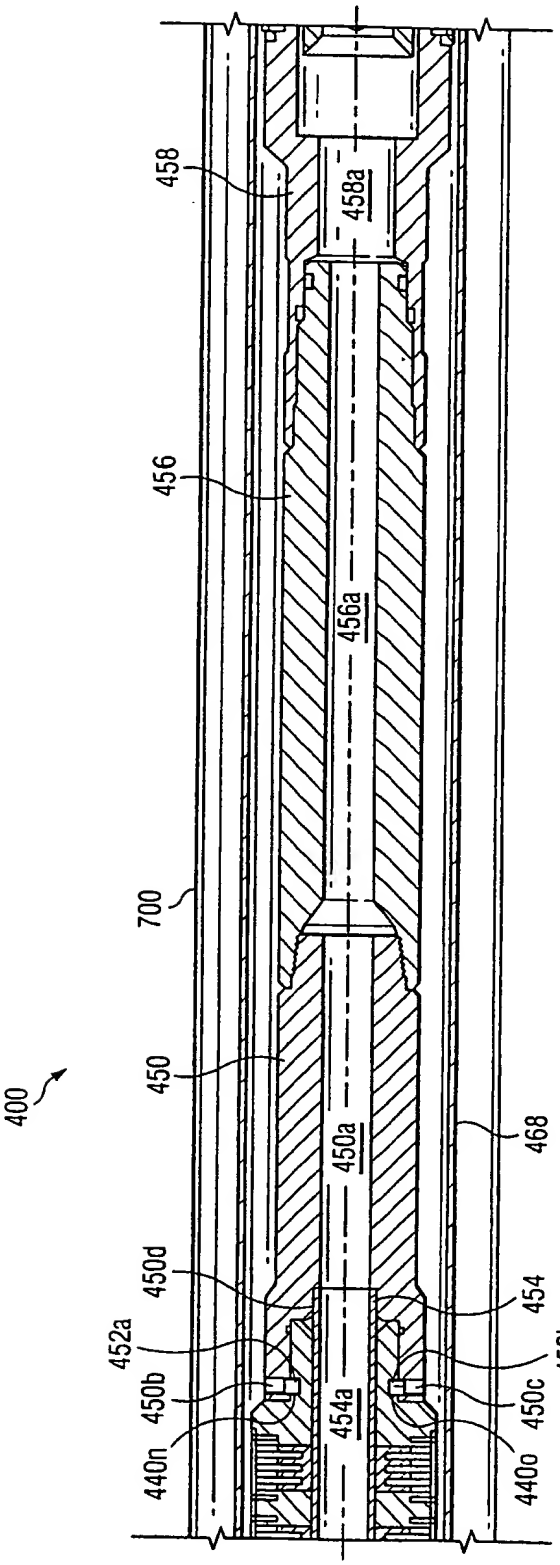
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Fig. 24c

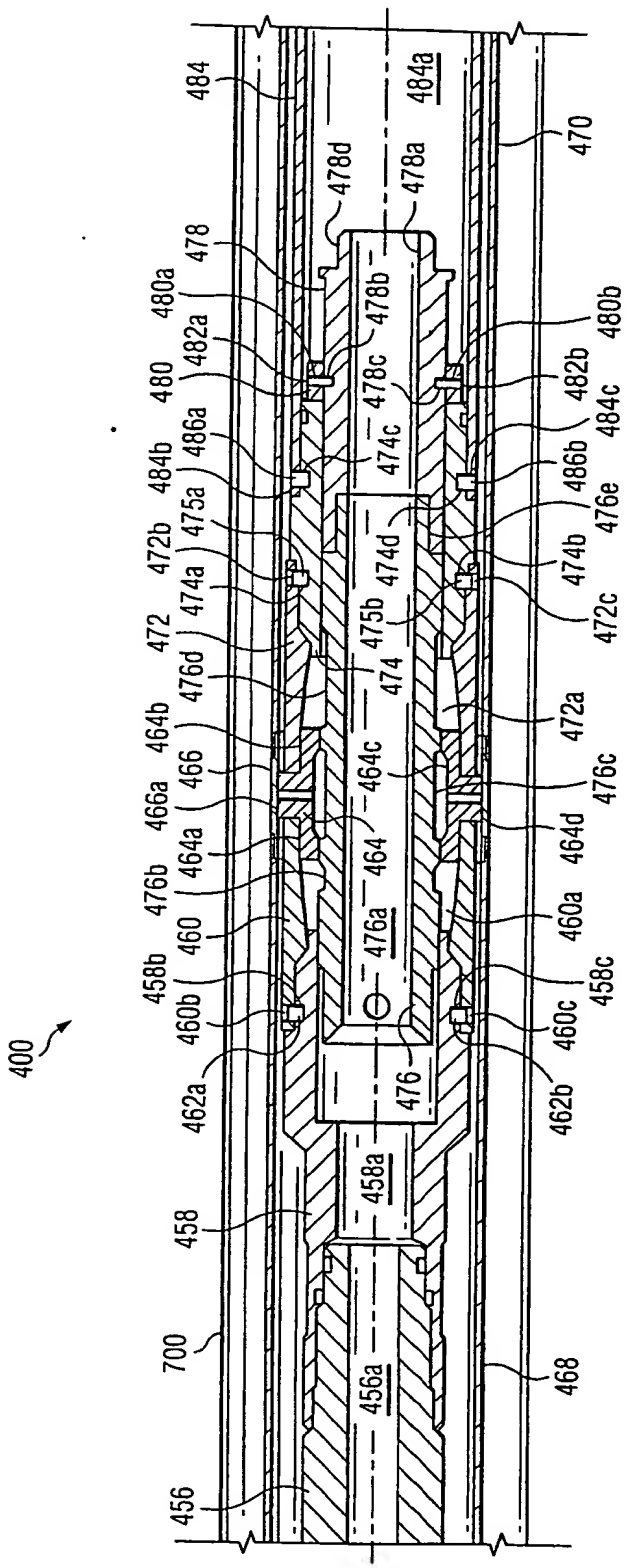
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Fig. 24d

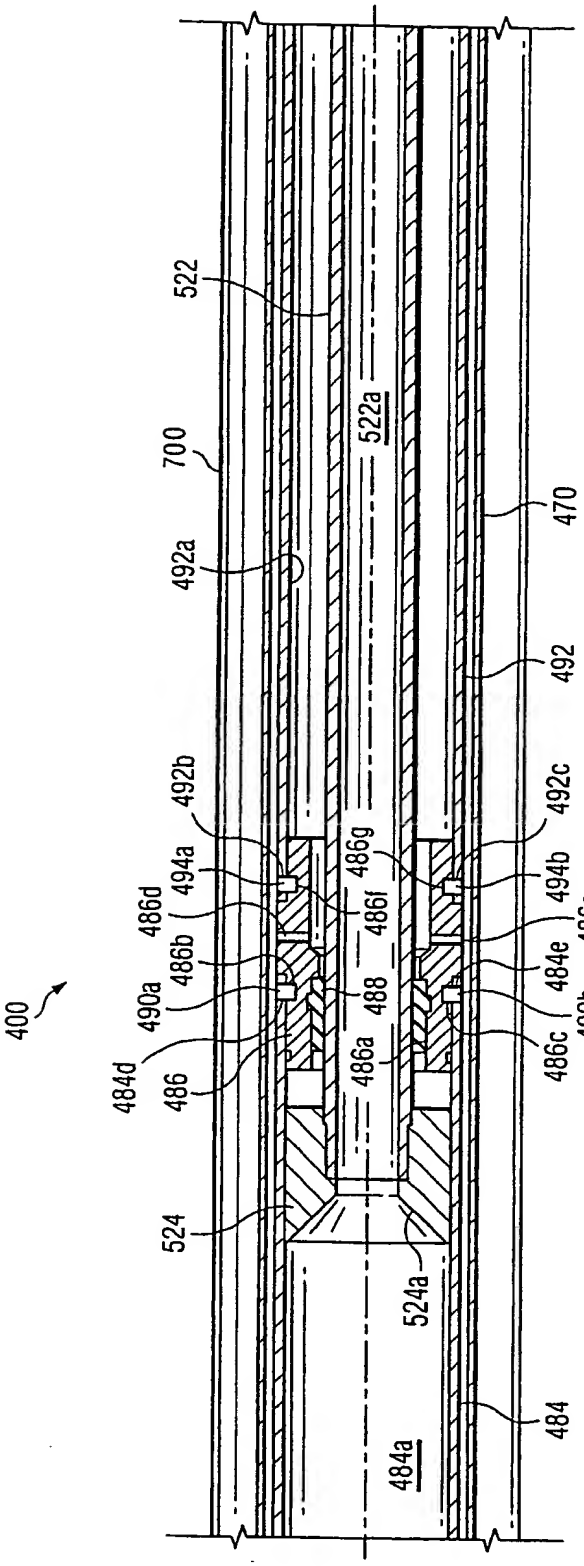
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Fig. 24e

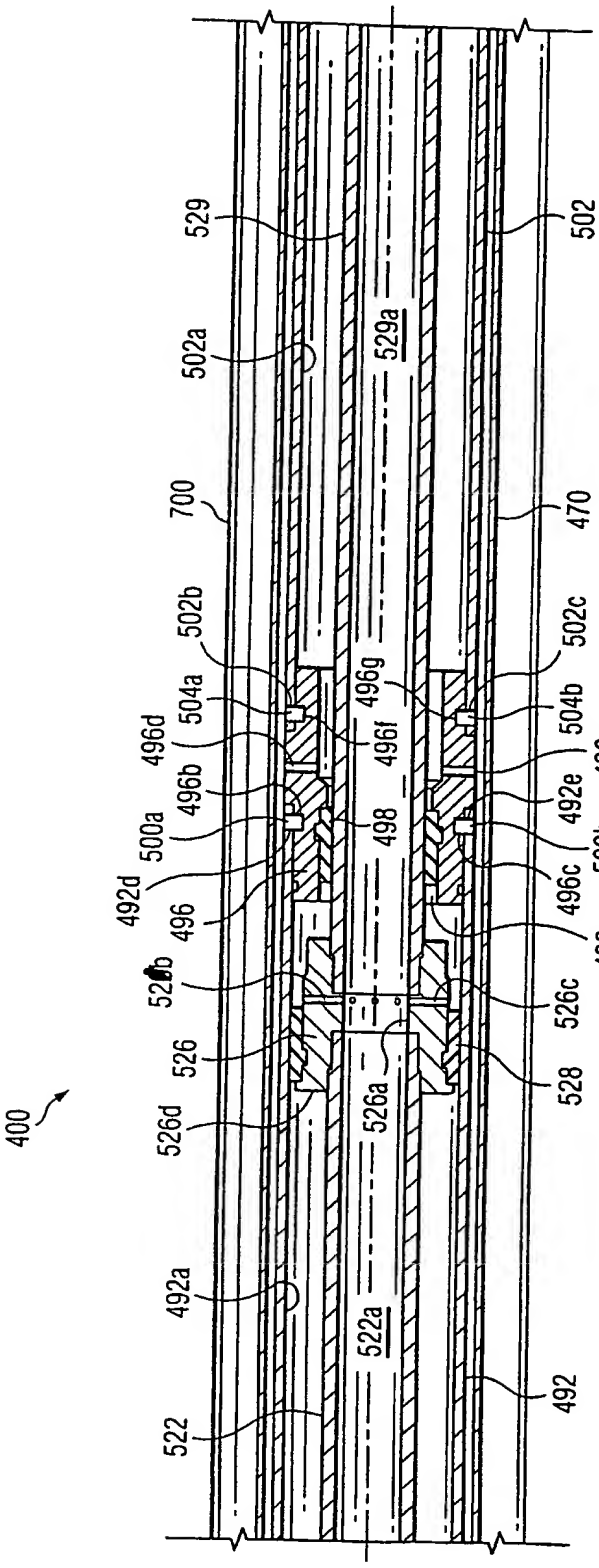
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Fig. 24f

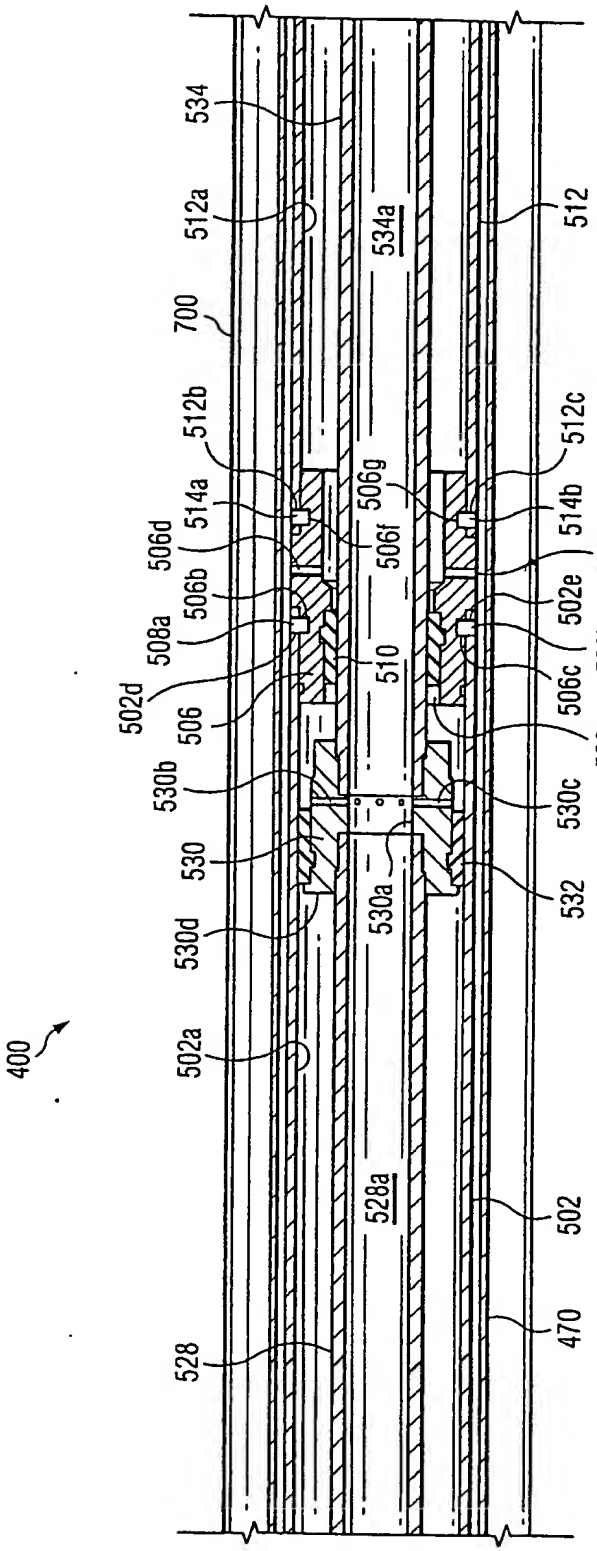
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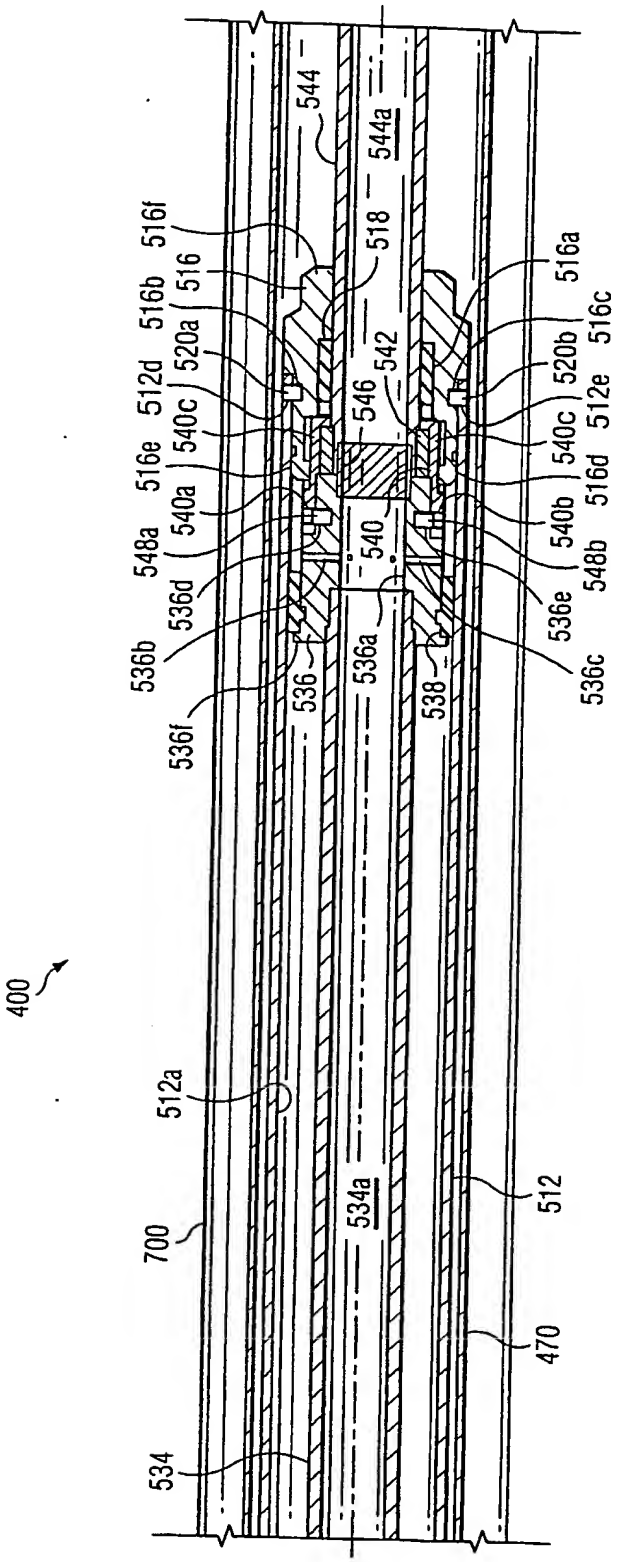
Fig. 24g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534
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512a
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536
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536b
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540a
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540c
512d
516b
520a
516
516f
544
544a
518
542
546
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536a
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536c
548b
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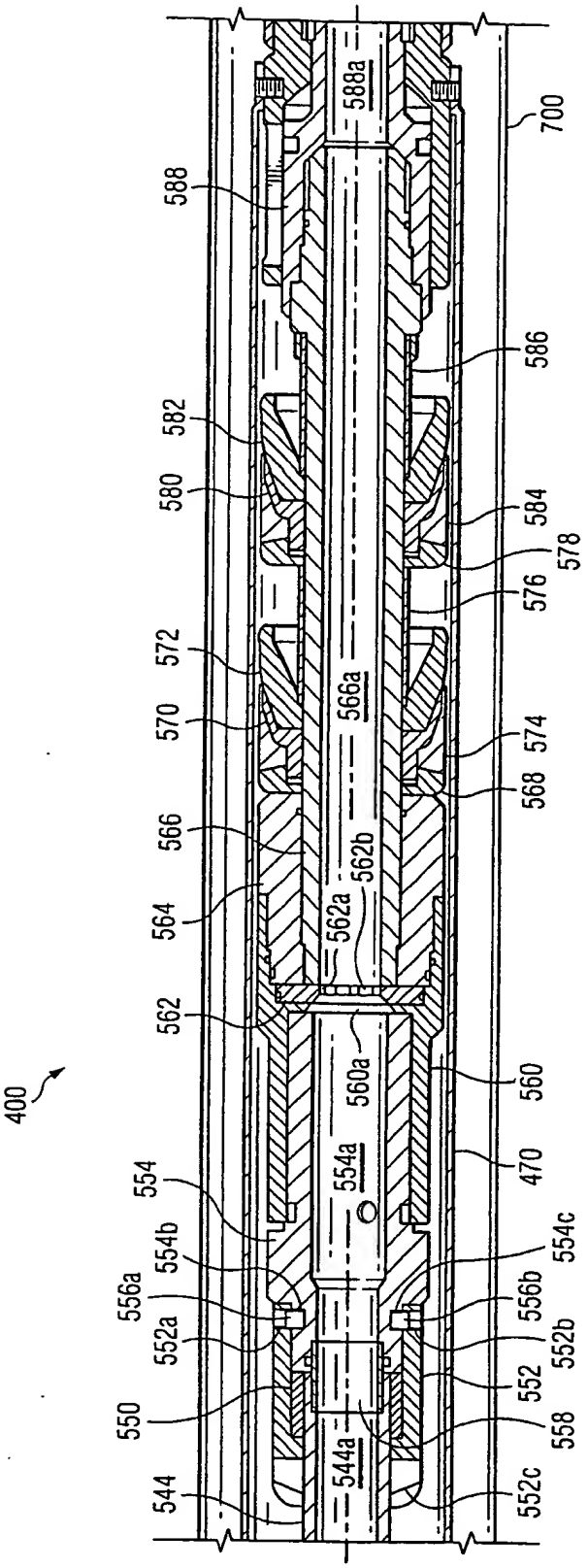
516d
512e
540c
520b
516c
516a
512
470

Fig. 24h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588a
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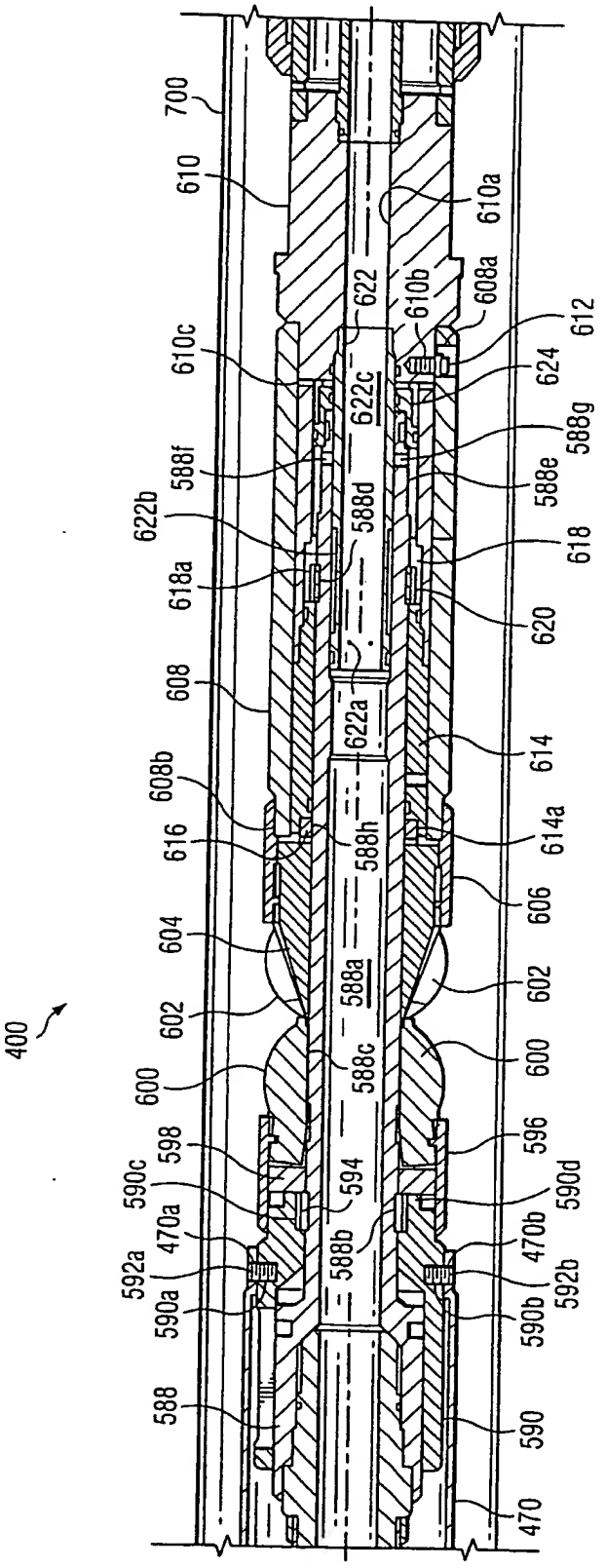
584
578
576
572
570
566a
574
568
566
562b
564
562a
562
560a
560
554a
470
554
554b
554c
556a
556b
552a
552b
552
550
558
544a
544
552c

Fig. 24i


400
700
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608a
622
610b
612
610c
624
622c
588g
588f
588e
588d
622b
618
618a
620
608
622a
614
608b
588h
614a
616
606
604
588a
602
602
600
588c
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596
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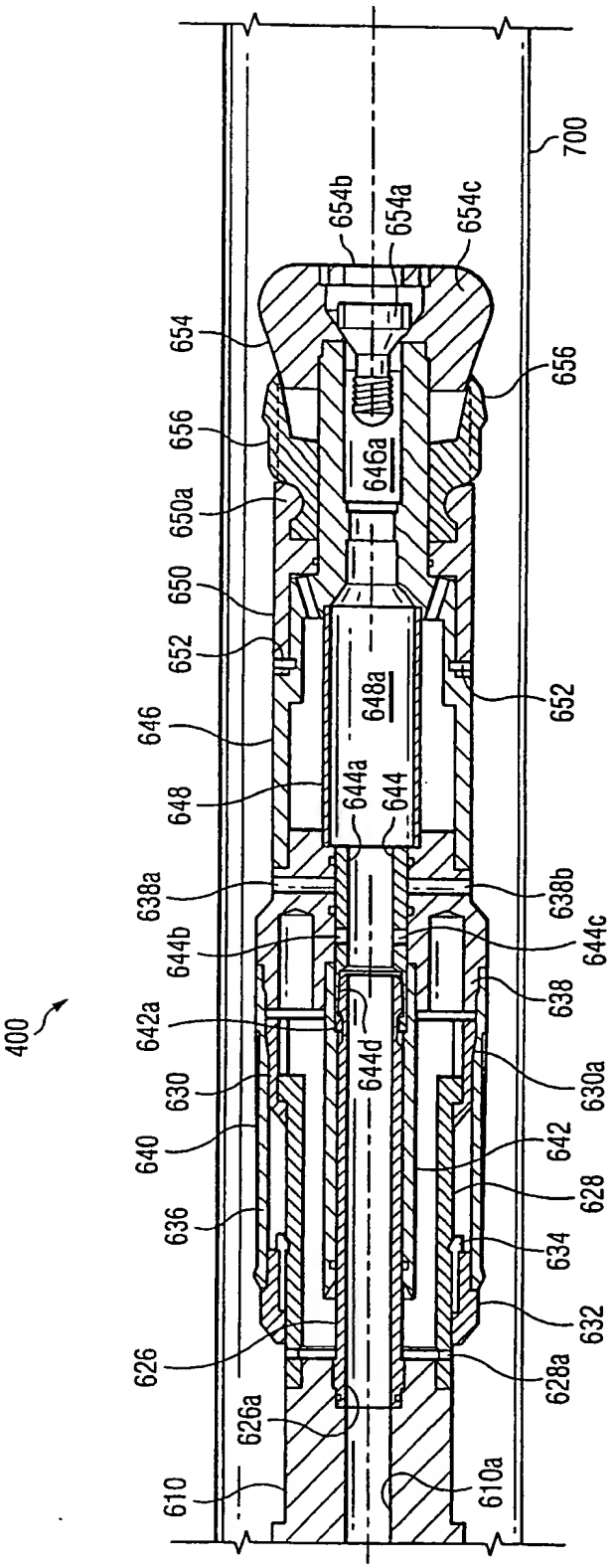
590c
590d
470a
470b
588b
592a
592b
590a
590b
588
590
470

Fig. 24j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700
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646a
650a
650
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646
648a
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644
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638a
638b
644b
644c
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644d
630
630a
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642
628
636
634
632
626
628a
626a
610
610a

Fig. 24k

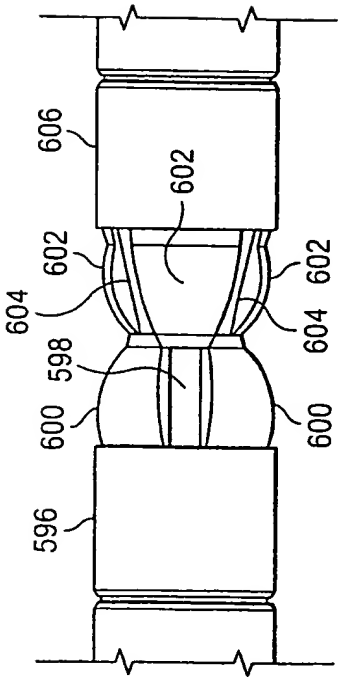


Fig. 25a

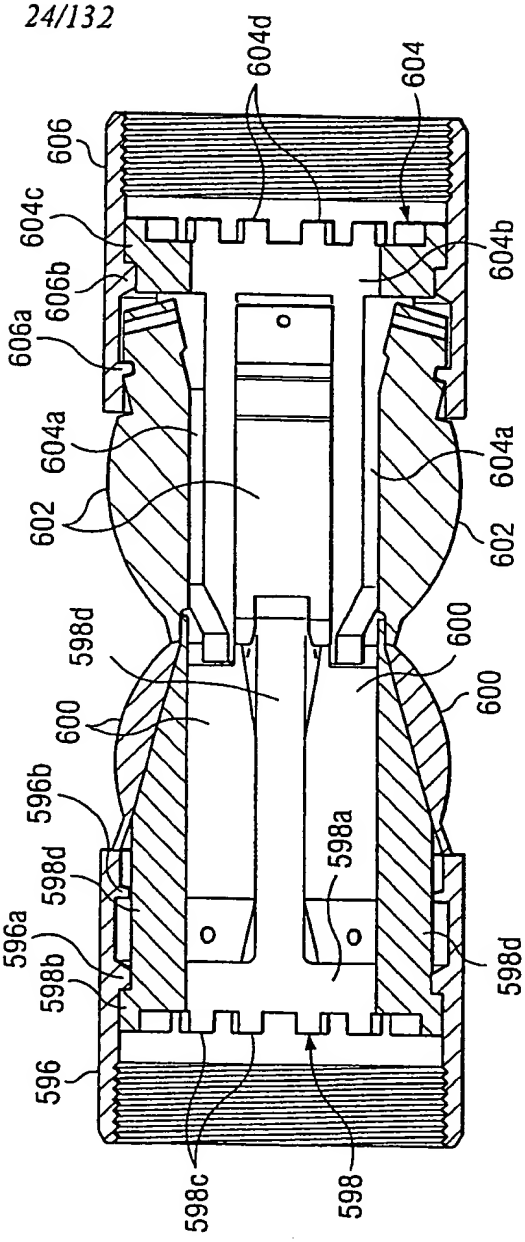


FIG. 25b

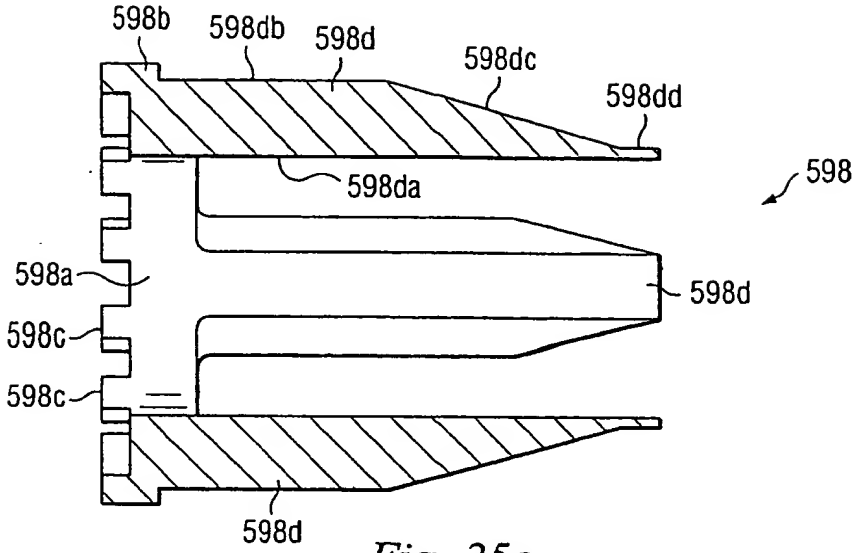


Fig. 25c

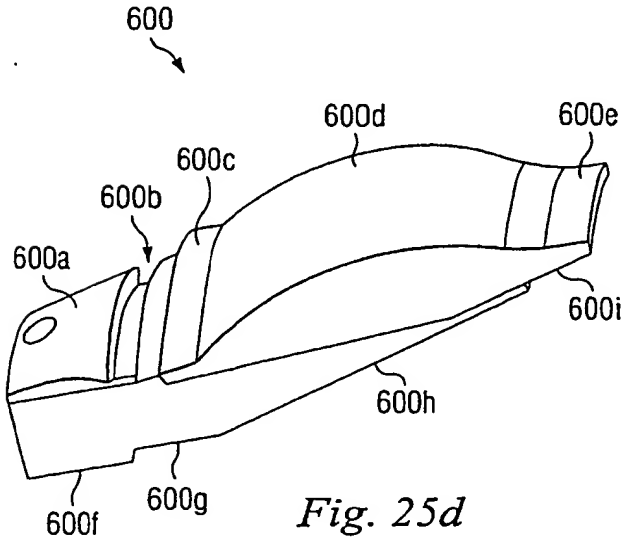


Fig. 25d

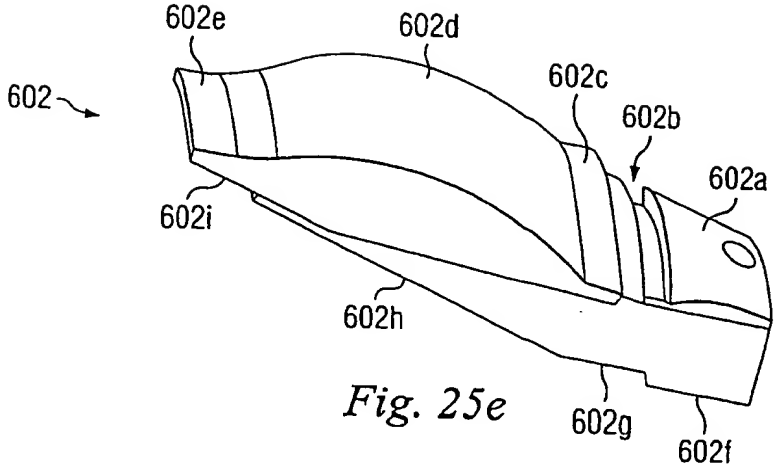


Fig. 25e

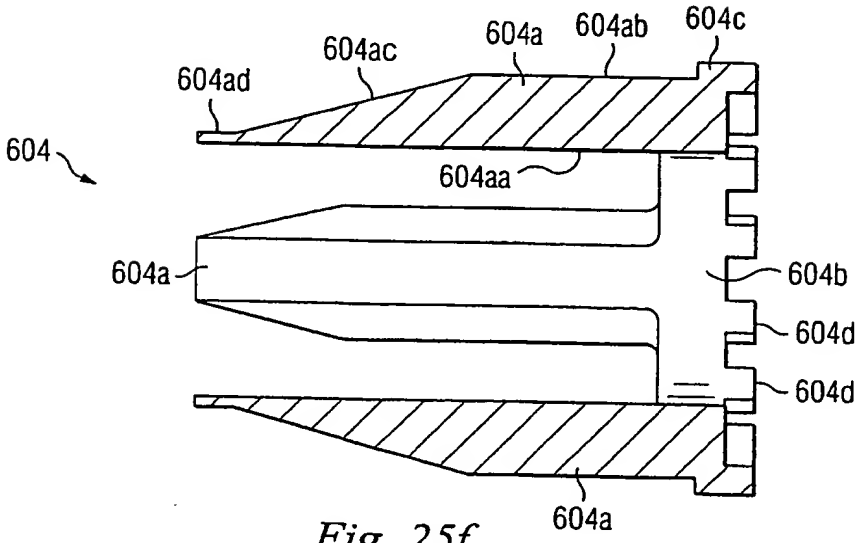


Fig. 25f

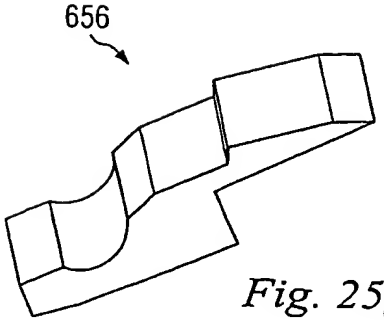
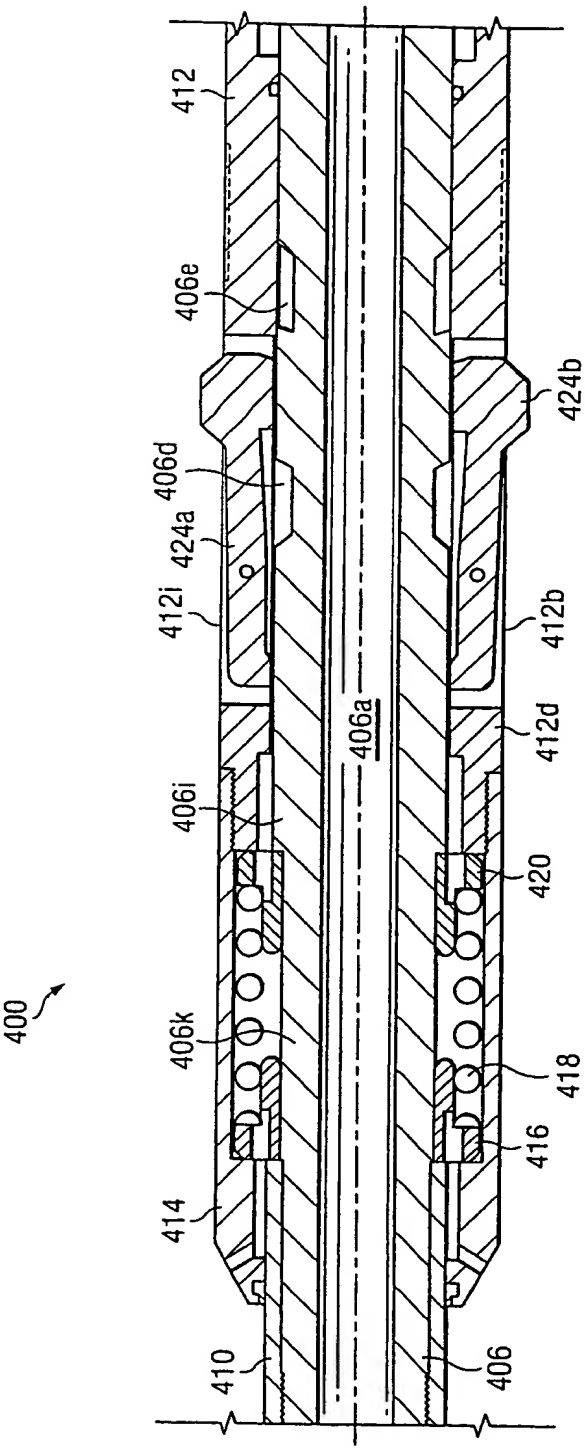


Fig. 25g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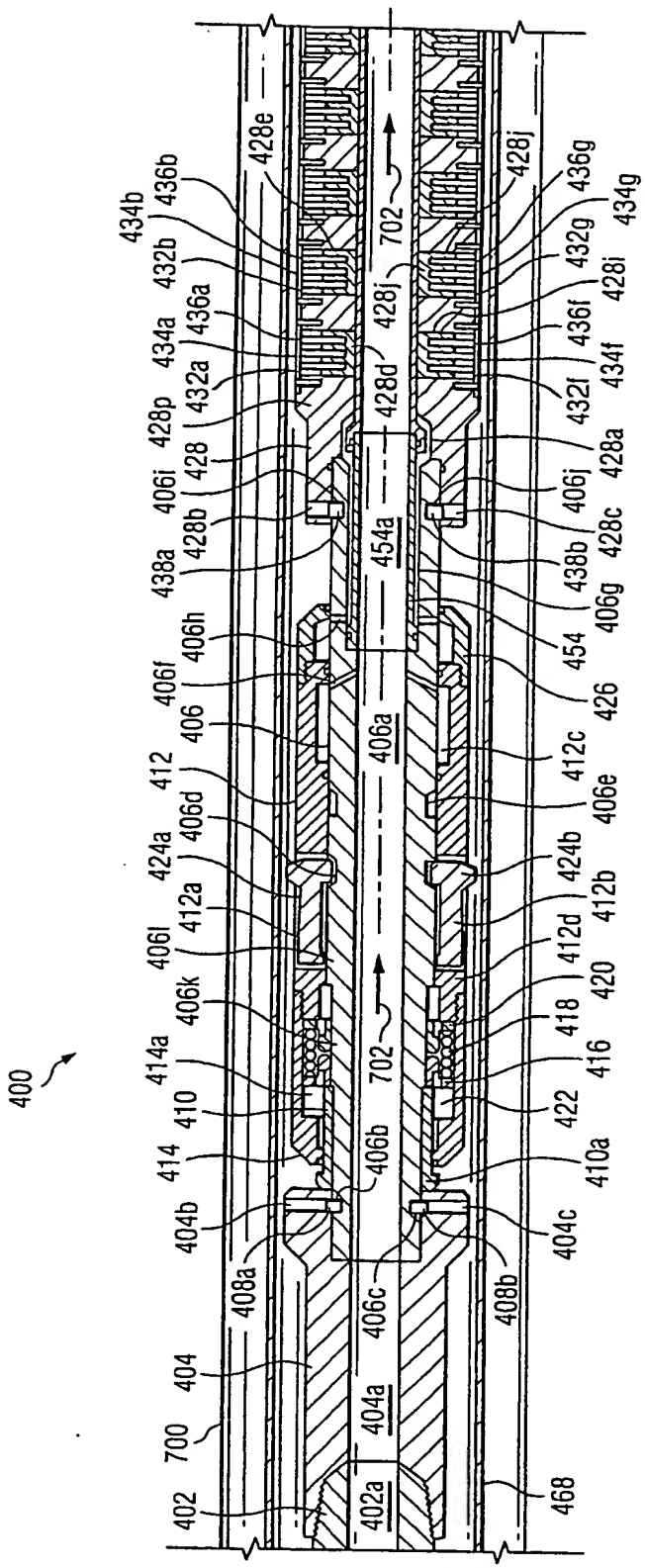
412
406e
424b
406d
424a
412i
412b
406a
412d
406i
420
406k
418
416
414
410
406

Fig. 25h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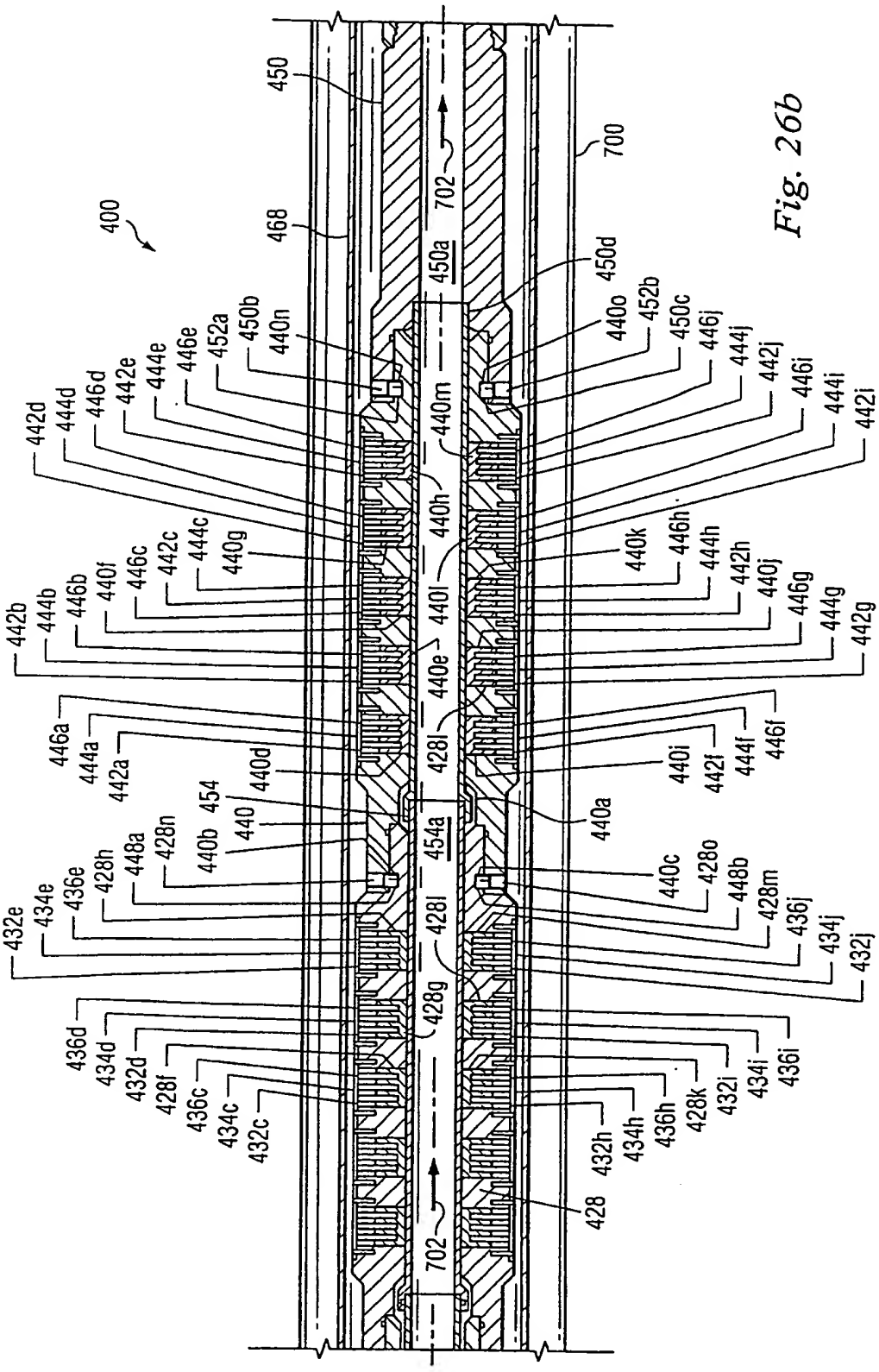
402a
404
404a
404b
404c
406
406a
406b
406c
406d
406e
406f
406g
406h
406i
406j
406k
406l
408a
408b
410
410a
412
412a
412b
412c
412d
414
414a
416
418
420
422
424a
424b
426
428
428a
428b
428c
428d
428e
428i
428j
428p
432a
432b
432f
432g
432l
434a
434b
434f
434g
436a
436b
436f
436g
438a
438b
454
454a
468
700
702

Fig. 26a


400
450
468
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702
700
450d
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450c
452a
450b
440n
440o
446j
444j
442j
446e
444e
442e
446d
444d
442d
440m
446i
444i
442i
440h
446h
444h
442h
440g
446c
444c
442c
440f
446b
444b
442b
440l
440k
446g
444g
442g
440e
446a
444a
442a
428l
446f
442f
444f
446l
440d
440i
454
440
440b
454a
440a
428n
448a
428h
436e
434e
432e
440c
428o
448b
428m
436j
434j
432j
428l
428g
436d
434d
432d
428f
436c
434c
432c
428
432h
434h
436h
428k
432i
434i
436i
702

Fig. 26b

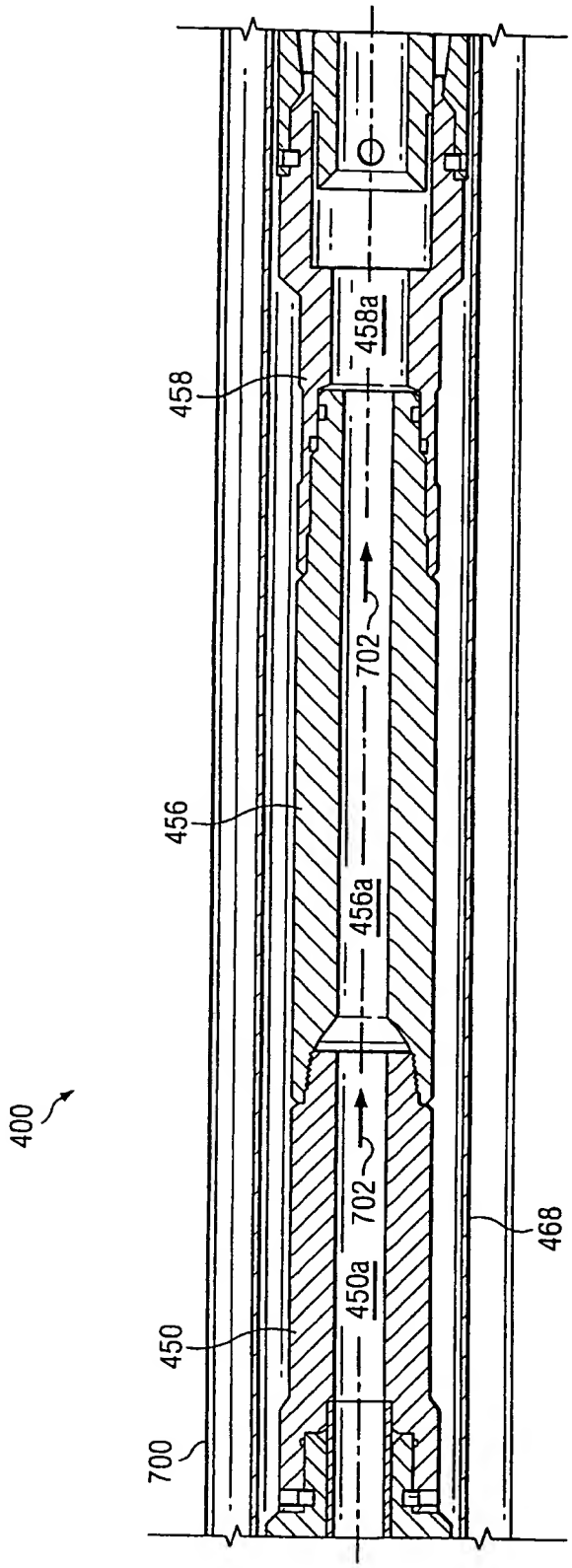
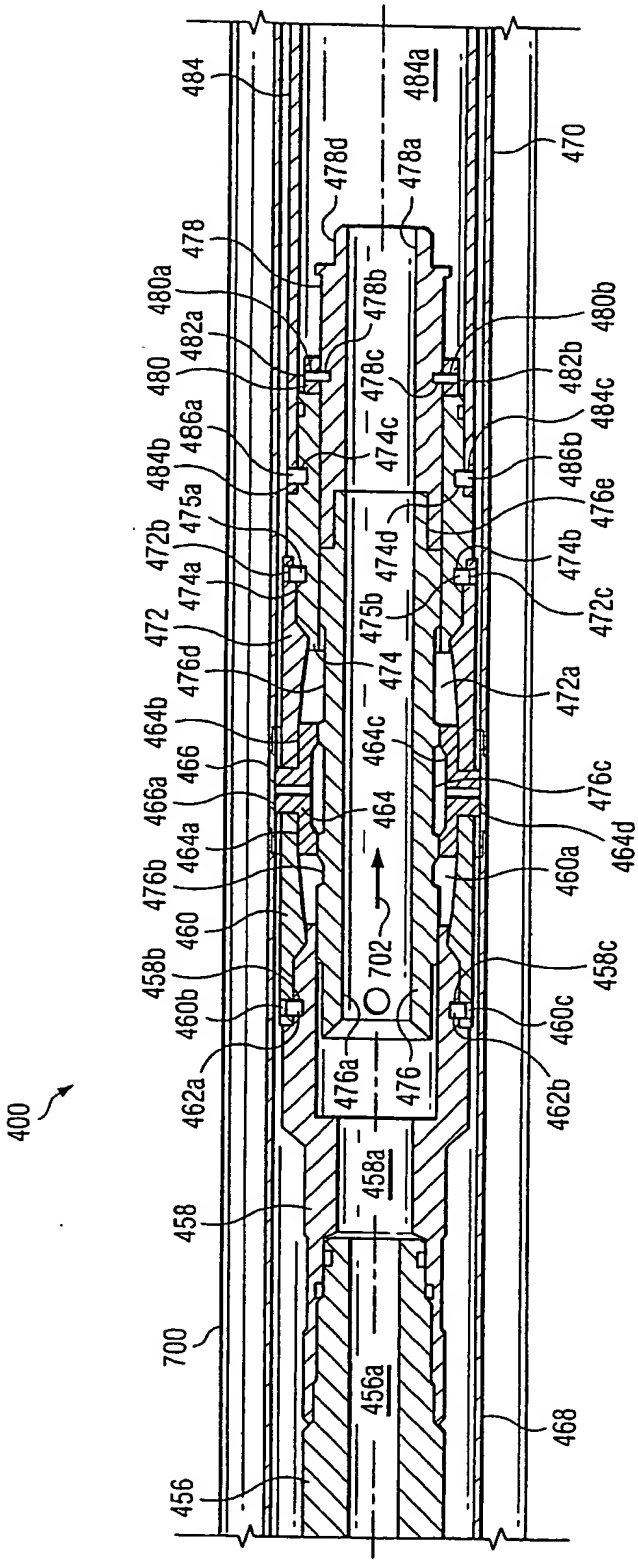


Fig. 26c


400
456
700
458
458a
456a
462a
460b
458b
460
476b
464a
466a
466
464b
476d
474a
472
475a
472b
484b
486a
480
482a
480a
478
484
484a
478a
478d
470
478b
480b
482b
478c
484c
474c
486b
476e
474b
472c
474d
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464c
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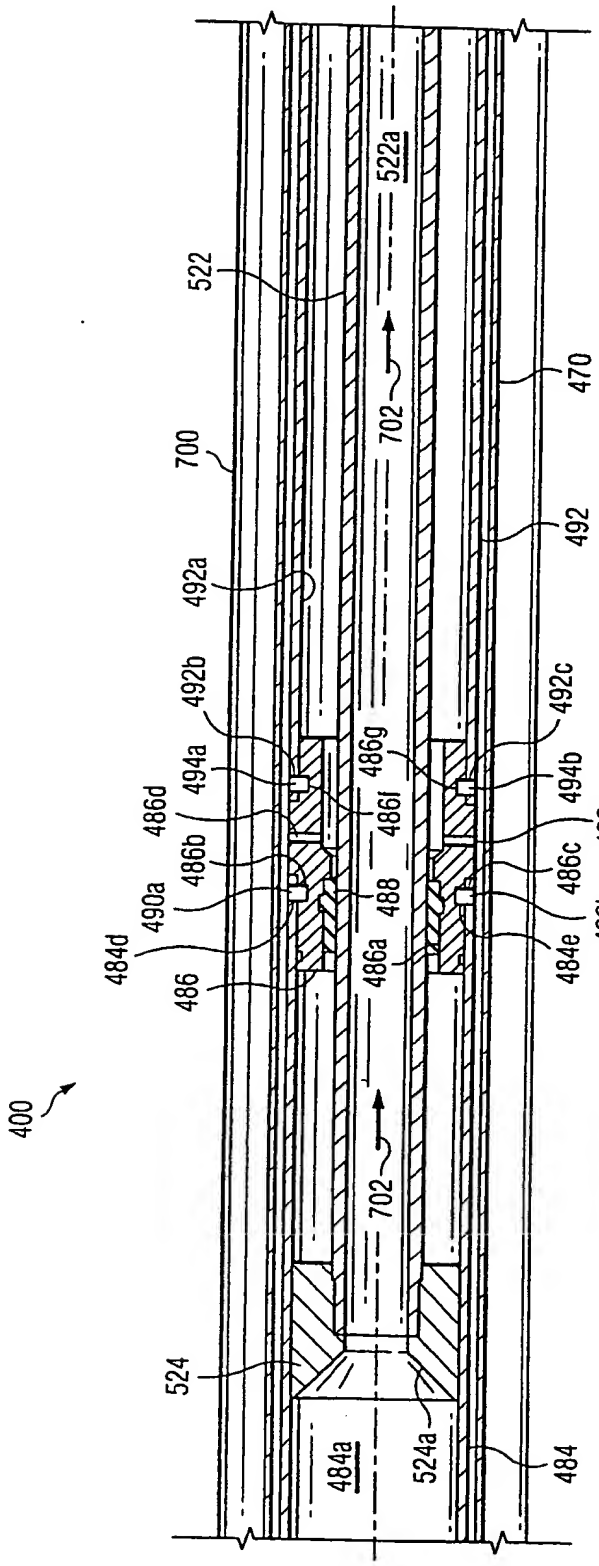
458c
460c
462b
476
476a
702

Fig. 26d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522
522a
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702
470
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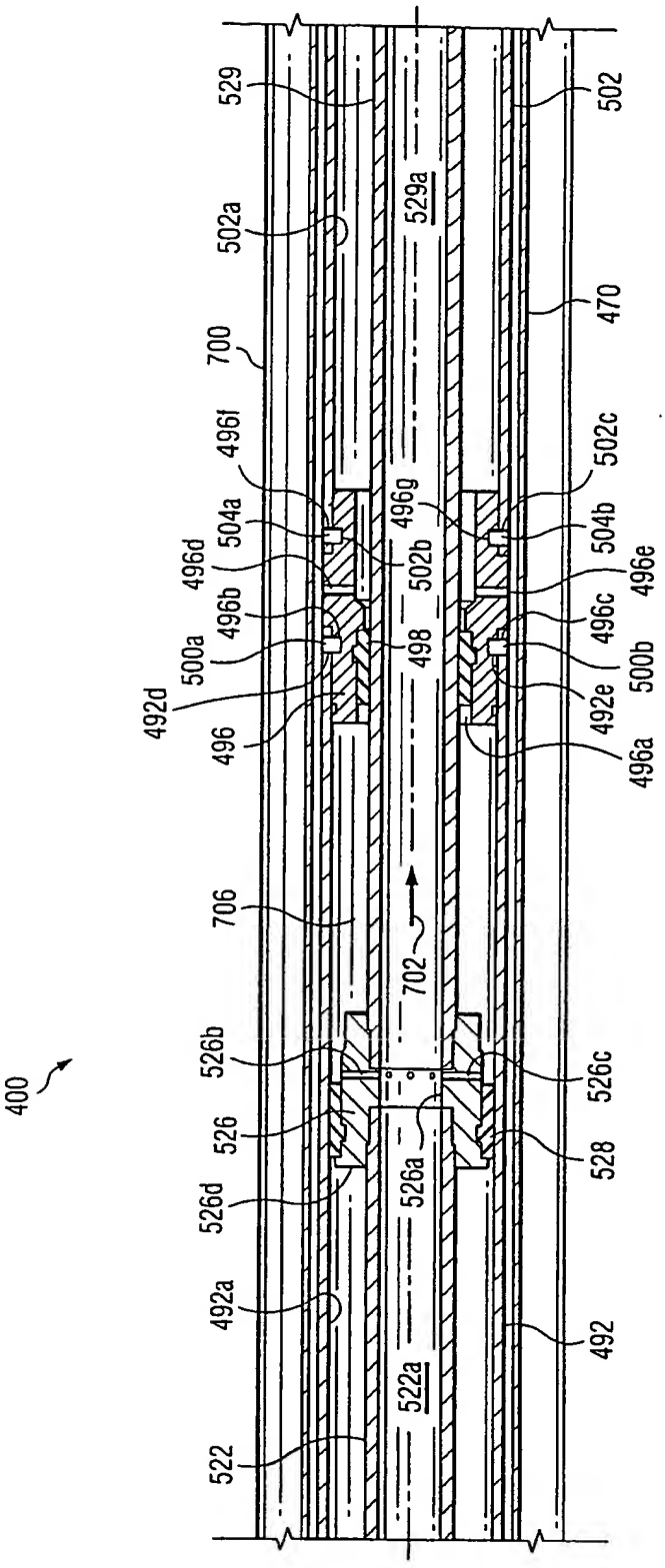
492b
492c
494a
494b
486d
486b
486g
486i
486e
486c
490a
488
490b
484d
486a
484e
486
524
524a
484a
484

Fig. 26e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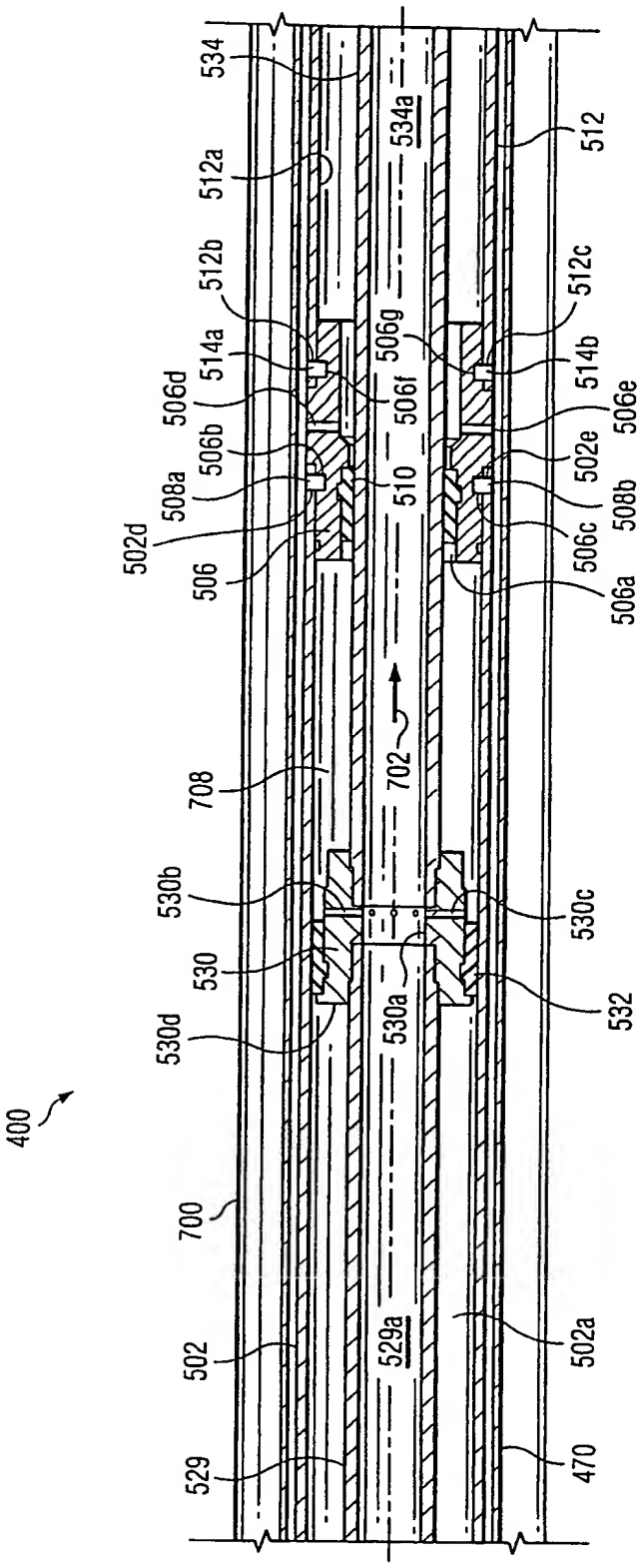
529
502
502a
529a
470
700
496f
502c
496g
504a
504b
496d
502b
496e
496b
496c
500a
498
500b
492d
492e
496
496a
706
702
526b
526c
526
528
526a
526d
492a
492
522a
522

Fig. 26f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512b
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514b
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506f
506d
506b
506e
502e
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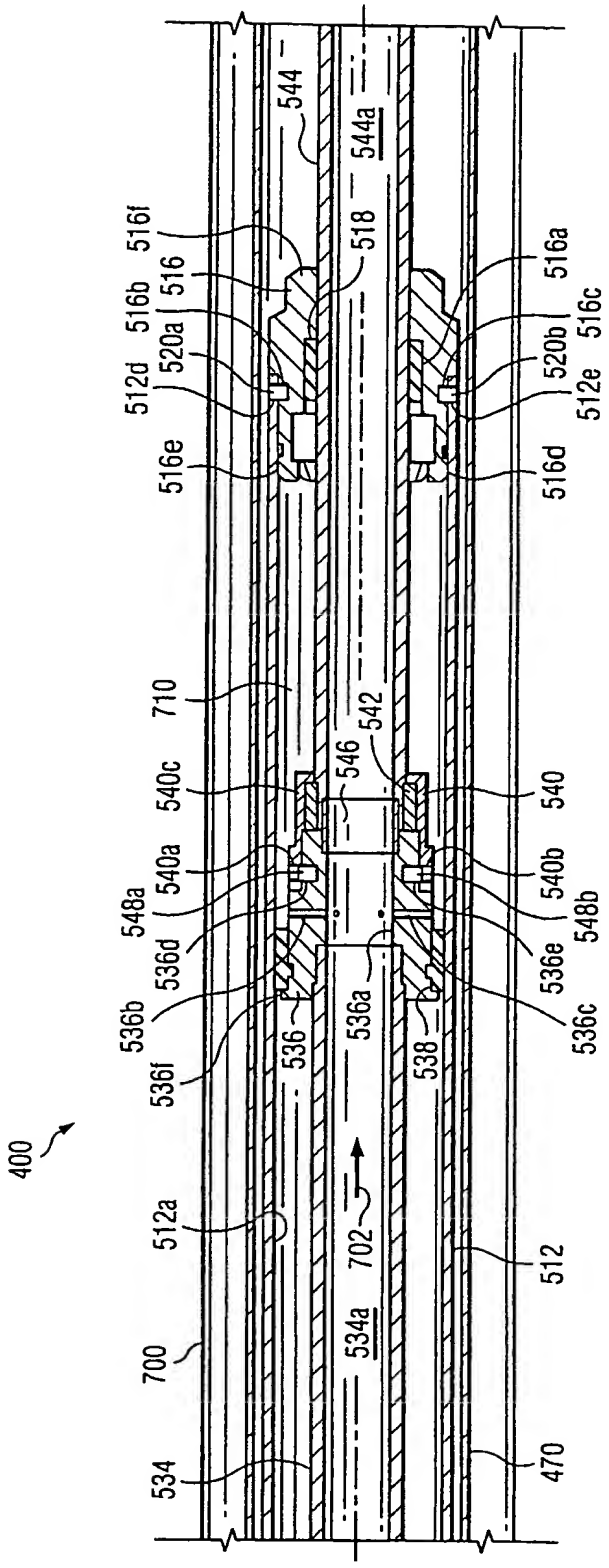
510
508b
502d
506
506c
506a
708
702
530b
530c
530
532
530d
530a
700
502
529a
502a
529
470

Fig. 26g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700
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536f
536b
548a
536d
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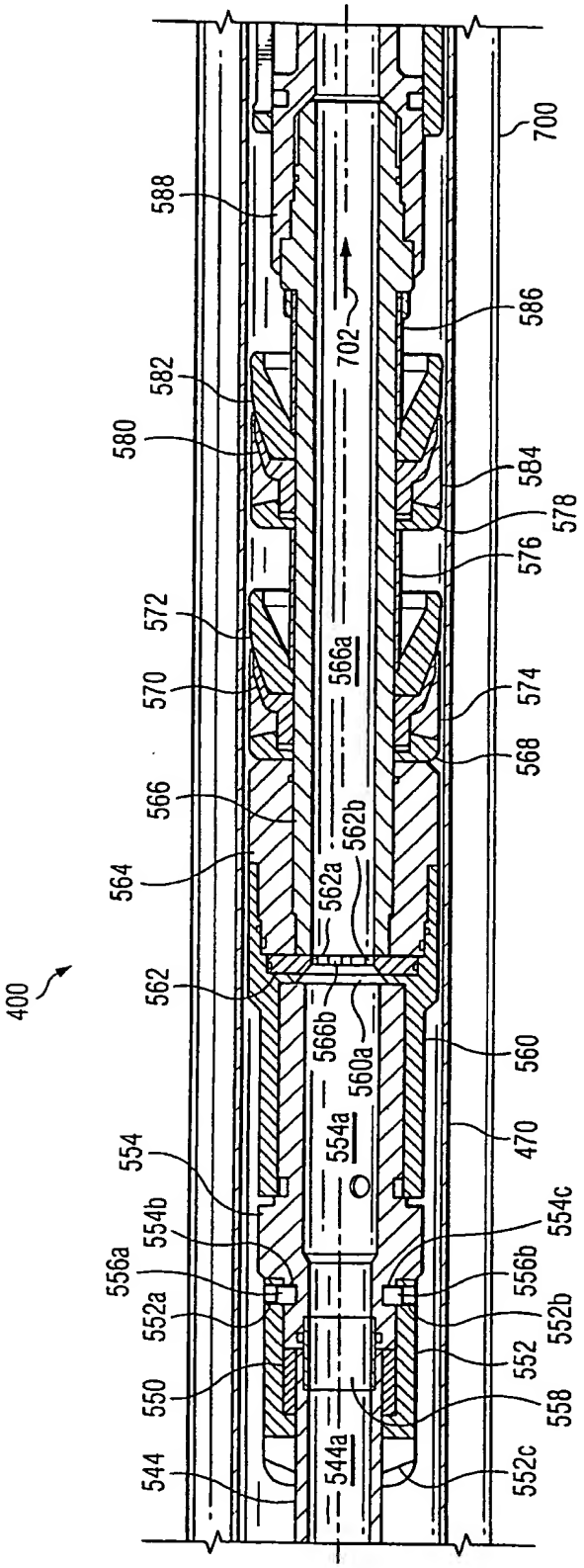
540c
710
512d
516b
516f
516e
520a
516
544
544a
518
516a
516c
520b
512e
516d
542
546
540
540b
548b
536e
536c
536a
538
536
702
534a
512
470

Fig. 26h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544
544a
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552a
552c
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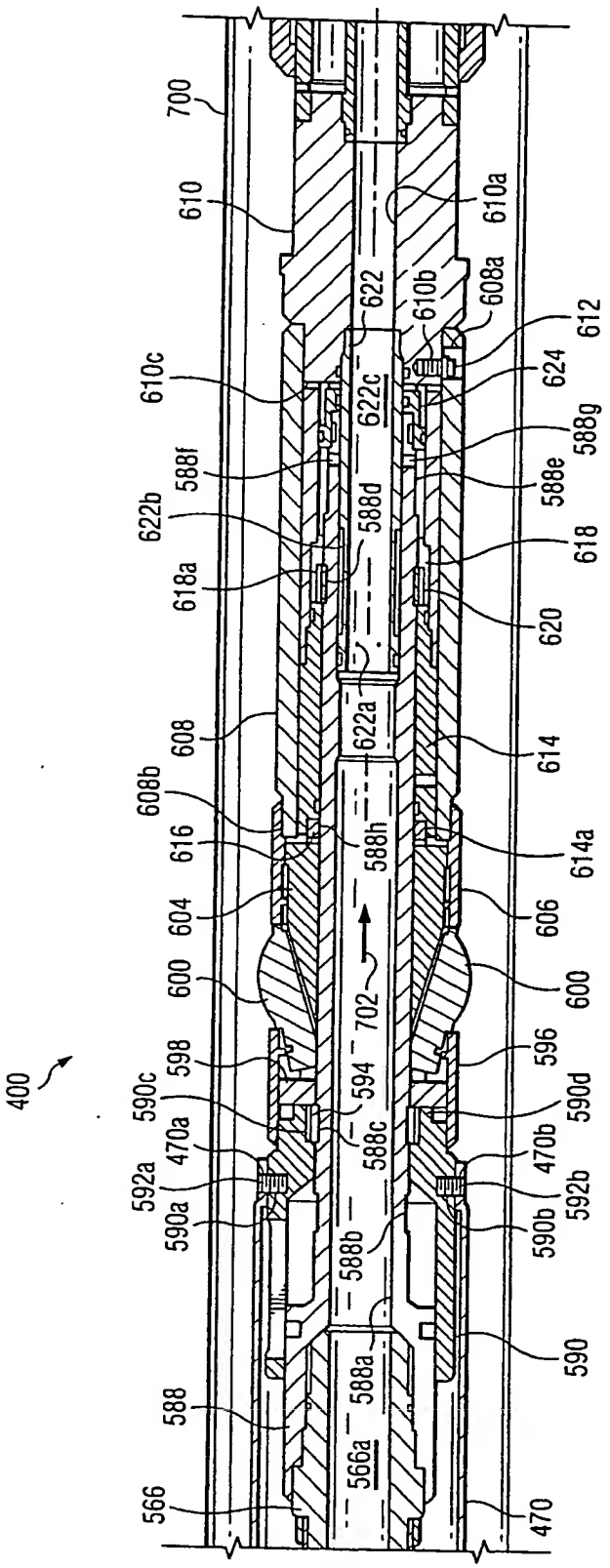
554a
554b
554c
556a
556b
558
560
560a
562
562a
562b
564
566
566a
566b
568
570
572
574
576
578
580
582
584
586
588
700
702
470
552
552b

Fig. 26i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700
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610a
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610b
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612
610c
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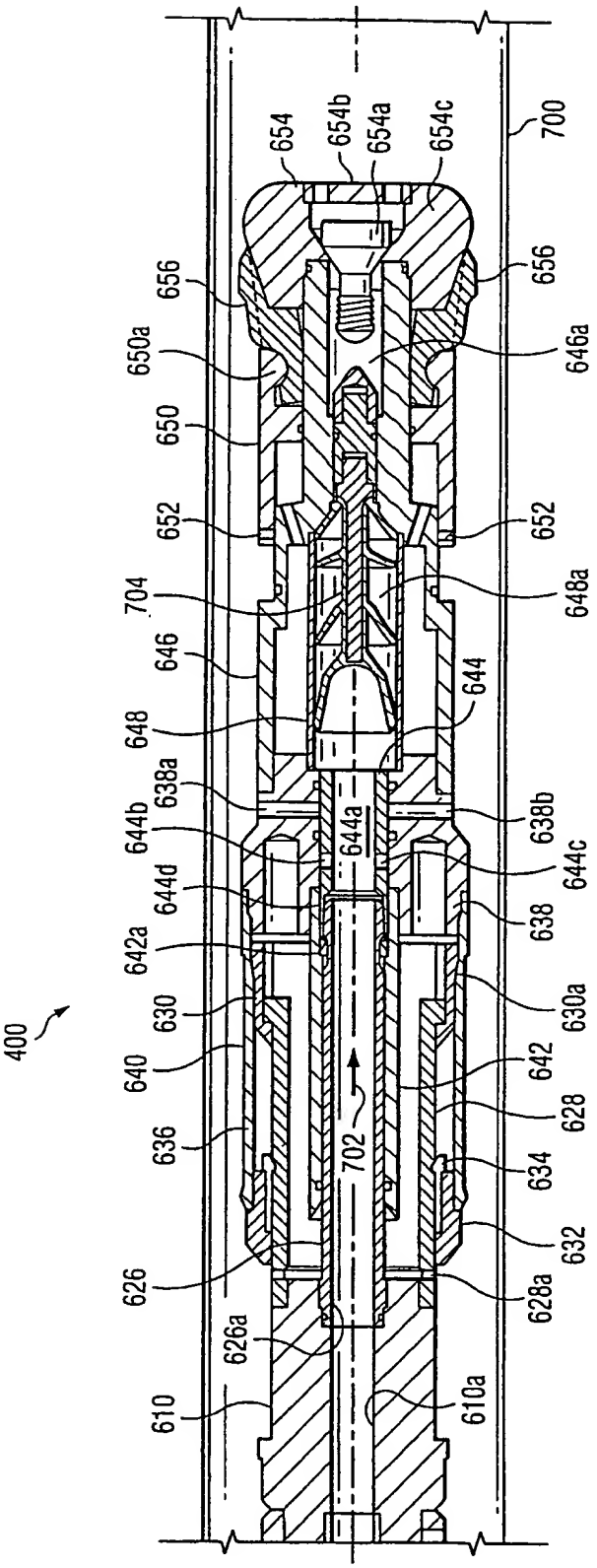
622c
588g
588f
588e
588d
622b
618
618a
620
608
622a
614
608b
588h
614a
616
604
606
600
702
600
598
596
590c
594
590d
588c
470a
470b
592a
592b
590a
590b
588b
590
588
588a
566a
566
470

Fig. 26j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610a
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626a
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628a
630
630a
632
634
636
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638a
638b
640
642
642a
644
644a
644b
644c
644d
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646a
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648a
650
650a
652
654
654a
654b
654c
656
700
702
704

Fig. 26k

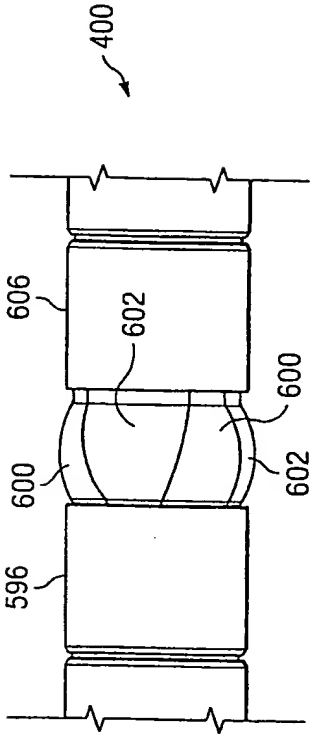


Fig. 27a

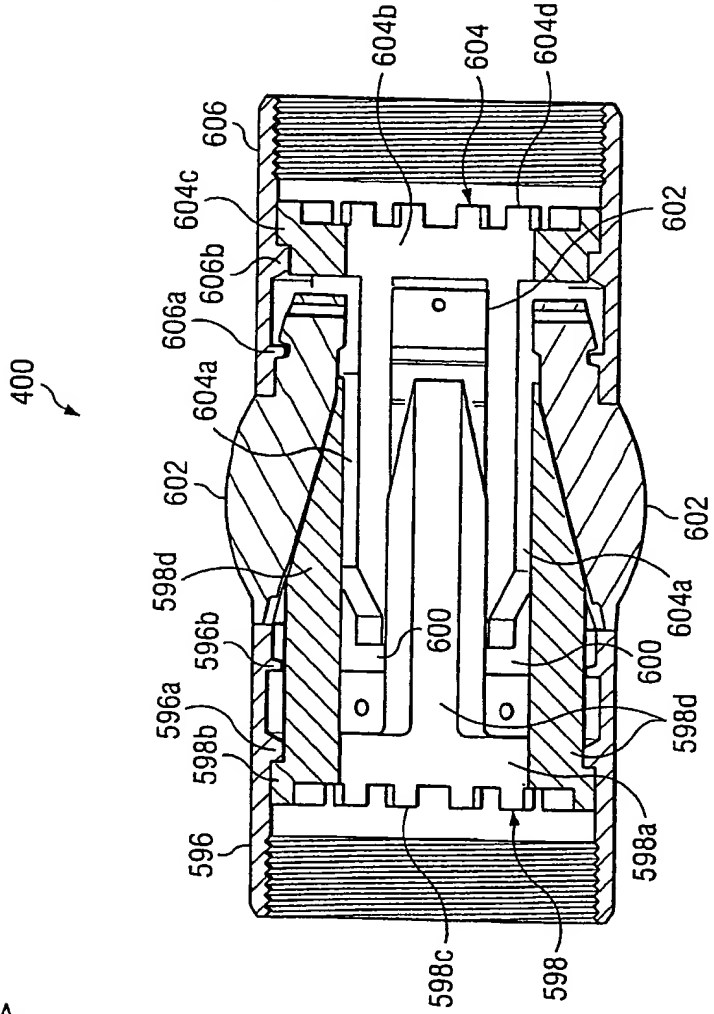
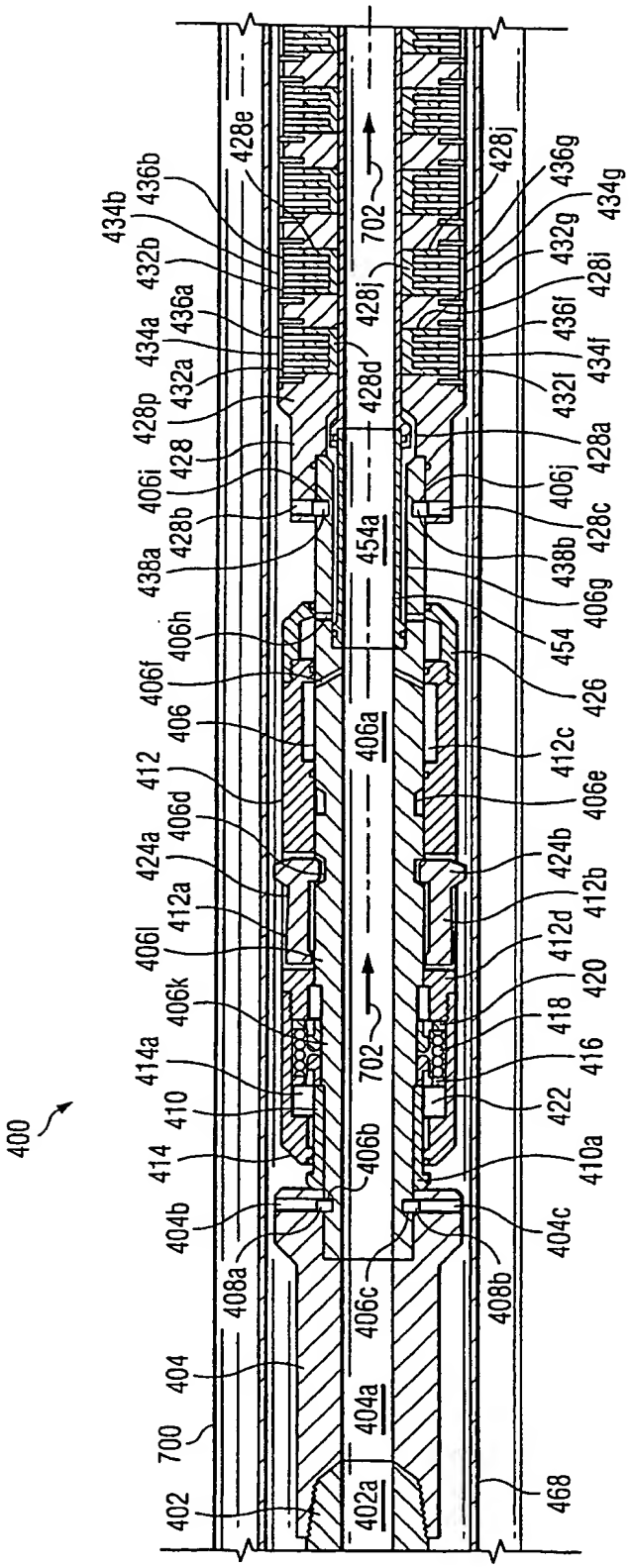


Fig. 27b


400
402
700
404
402a
404a
468
404b
408a
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414a
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406k
406l
412a
424a
406d
412
406
406f
406h
428b
438a
406i
428
428p
432a
434a
436a
432b
434b
436b
428e
406b
406c
408b
404c
410a
422
416
420
418
412d
412b
424b
406e
412c
426
454
406g
438b
428c
406j
428a
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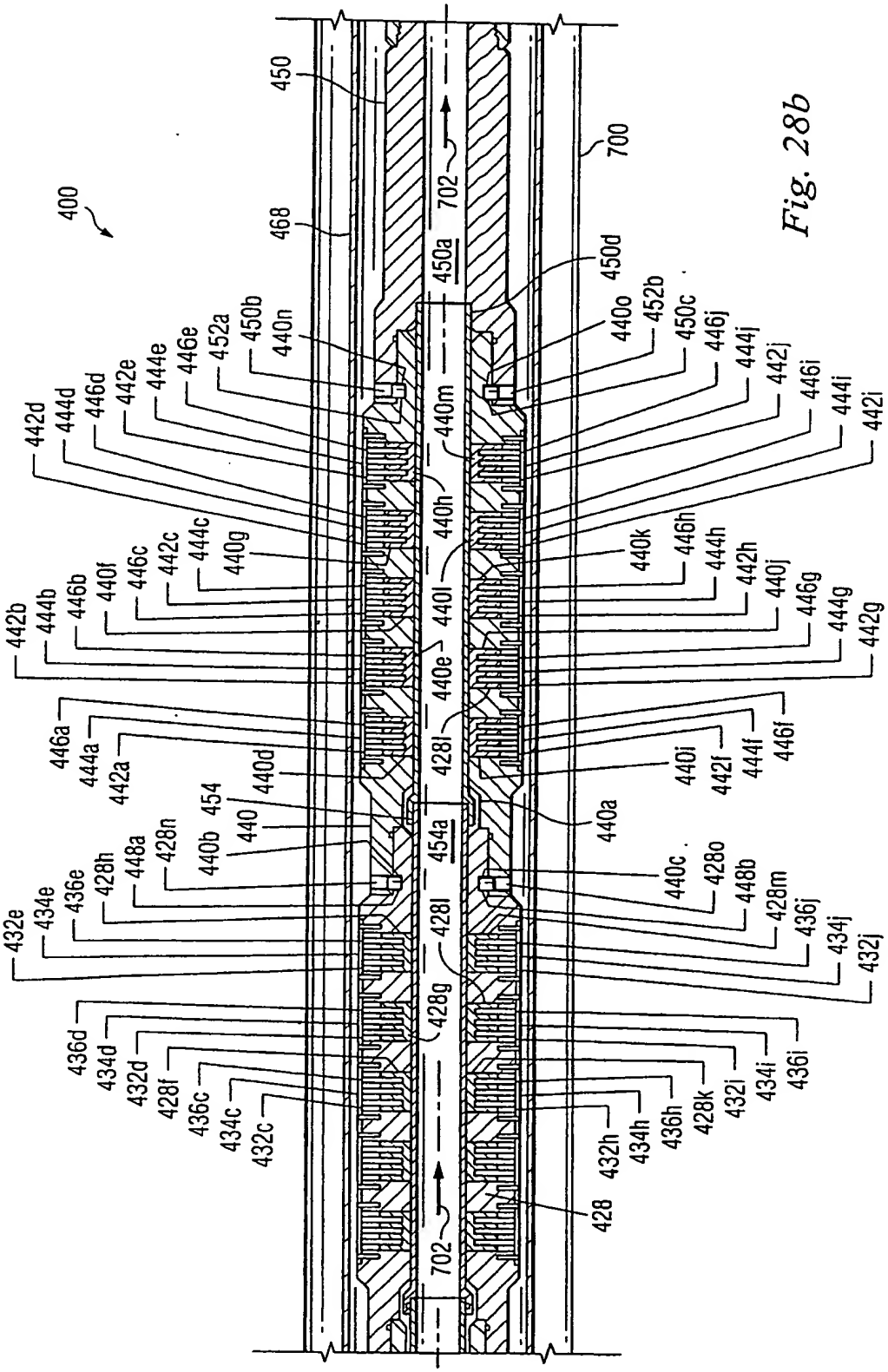
436f
428i
432g
434g
436g
428j
428d
428j
702
454a
406a

Fig. 28a


400
450
468
700
702
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452b
450c
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450b
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440o
446j
444j
442j
446e
444e
442e
446d
444d
442d
440m
446i
444i
442i
440h
440k
446h
444h
442h
440j
446g
444g
442g
440l
440e
446c
444c
442c
440g
446b
444b
442b
440f
446a
444a
442a
440d
428l
440i
442l
444f
446f
454
440
440b
428n
448a
428h
436e
434e
432e
454a
440a
440c
428o
448b
428m
436j
434j
432j
428l
428g
436d
434d
432d
428f
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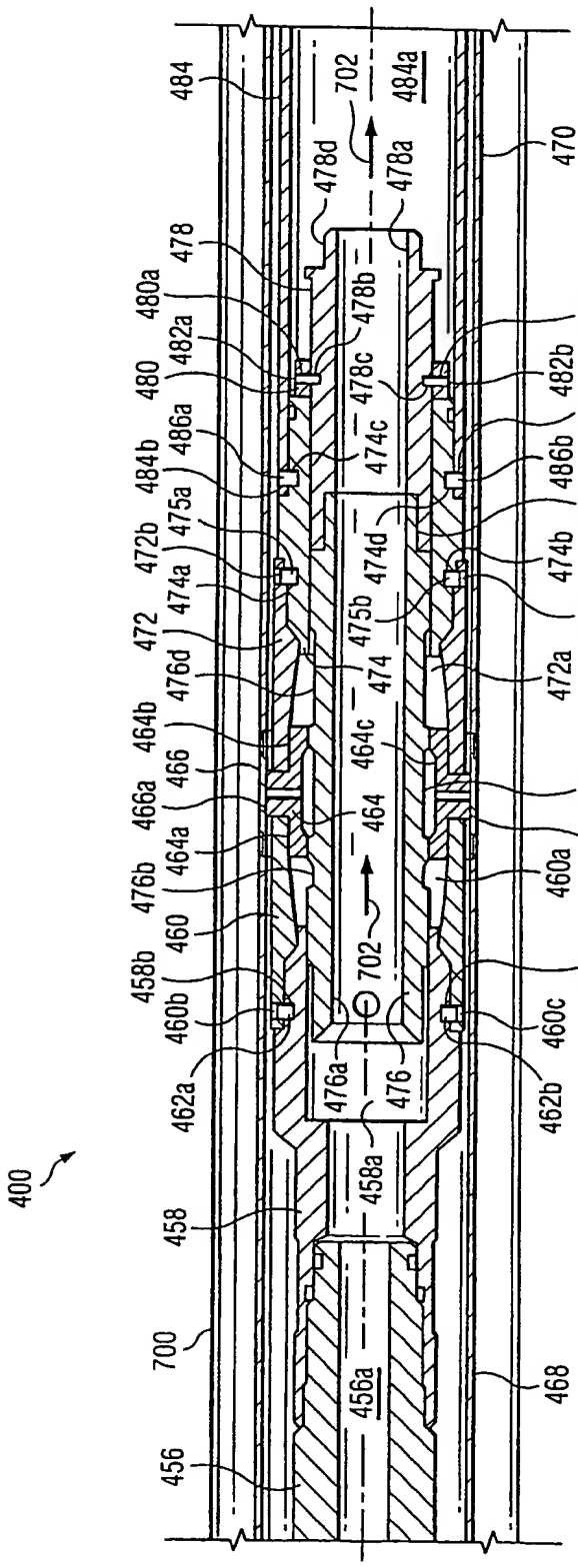
434c
432c
428
432h
434h
436h
428k
432i
434i
436i
702

Fig. 28b


400
456
700
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462a
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466
472
476d
474a
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484b
486a
480
482a
480a
478
484
478d
702
484a
478a
470
478b
480b
478c
482b
474c
484c
486b
474d
476e
475b
474b
472c
472a
474
464c
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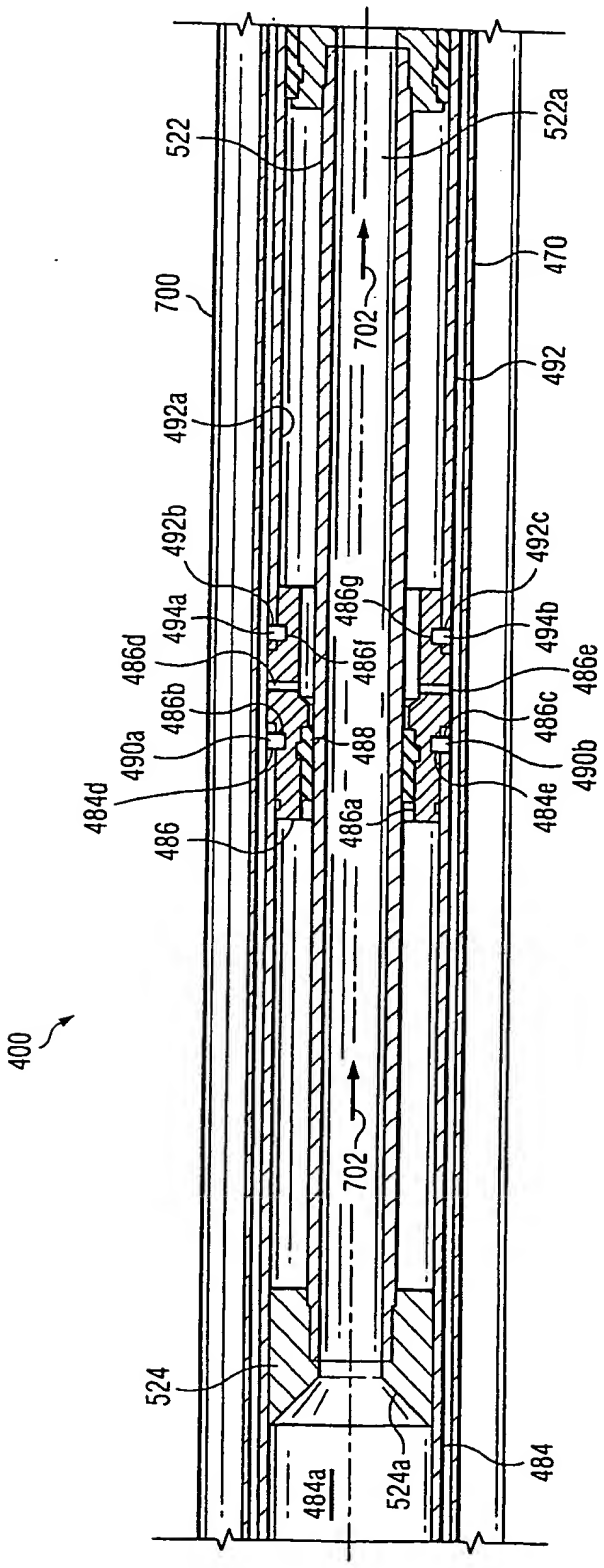
464
464d
460a
458c
460c
462b
476
476a
458a
456a
468

Fig. 28c


400
522
522a
700
470
702
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492a
492b
492c
494a
494b
486g
486d
486f
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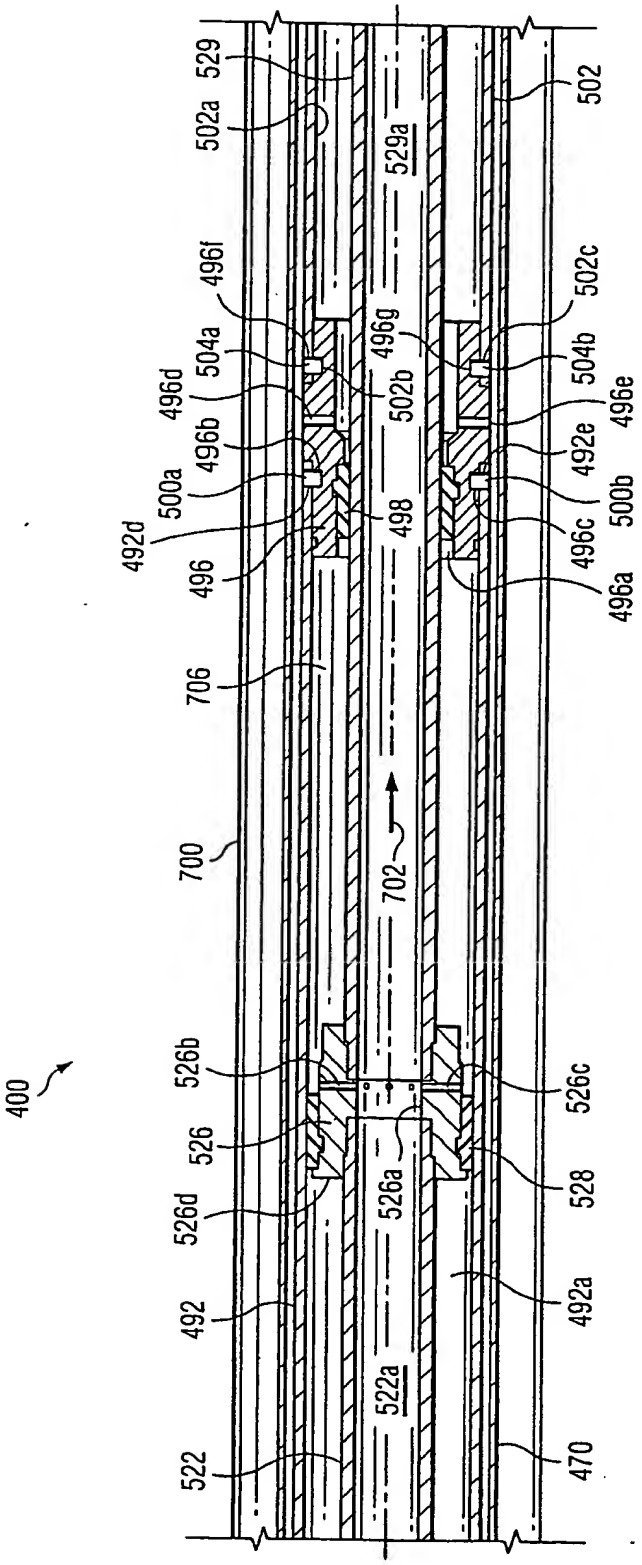
486e
486c
490a
488
490b
484d
484e
486
486a
524
484a
524a
484

Fig. 28d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526d
526
526b
700
706
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492d
500a
496b
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504a
496f
529
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502
502c
504b
496e
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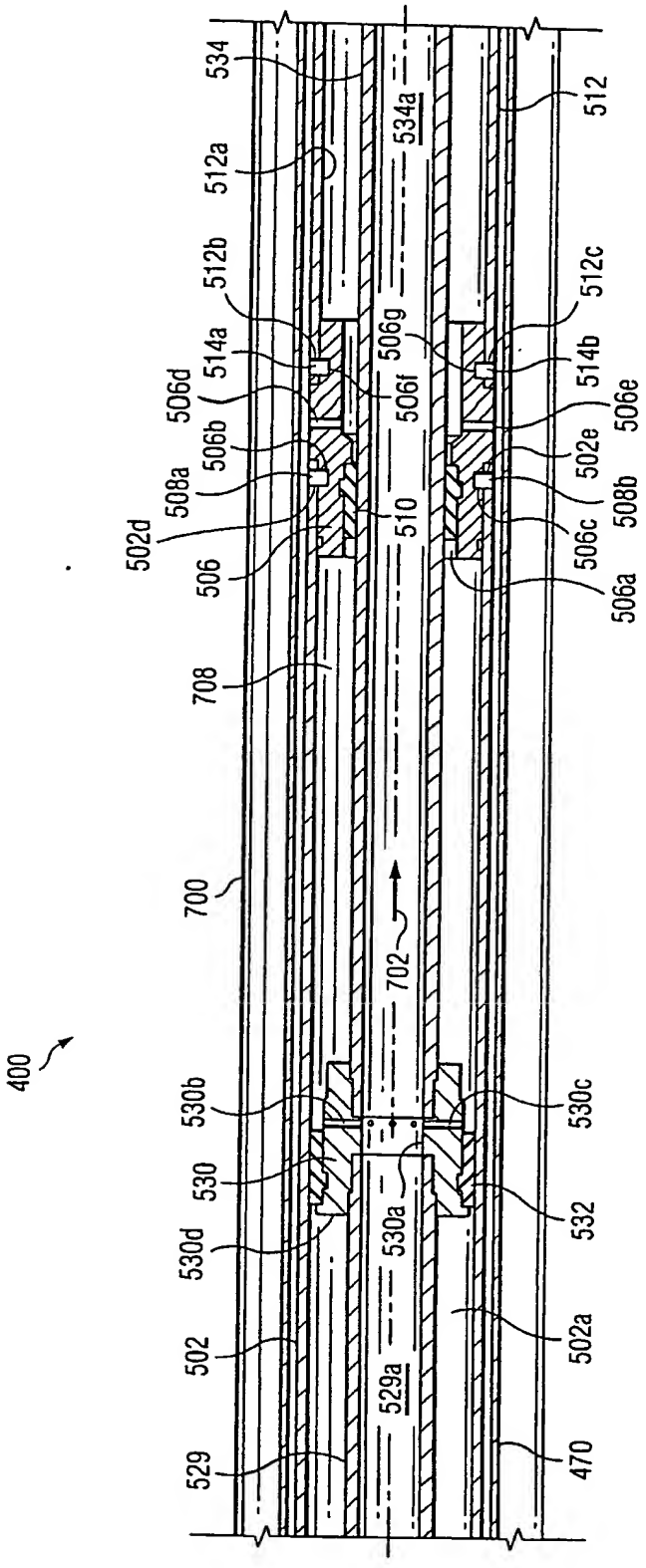
496g
526c
528
492a
470
522a
526a
702

Fig. 28e


400
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512a
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506d
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502d
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708
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530b
530
530d
502
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530a
534a
512
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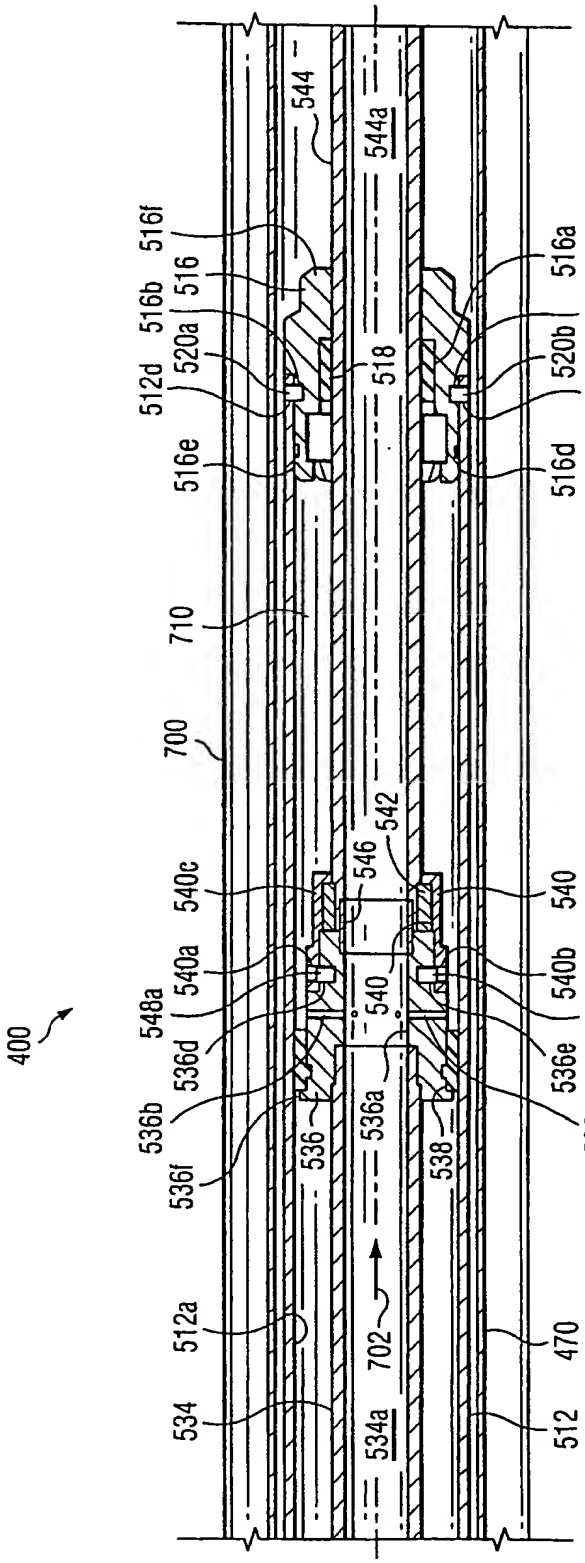
506g
506f
510
702
532
502a
470

Fig. 28f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542
546
710
700
516f
516b
516
520a
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544a
518
516a
516c
520b
512e
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536a
540
538
536e
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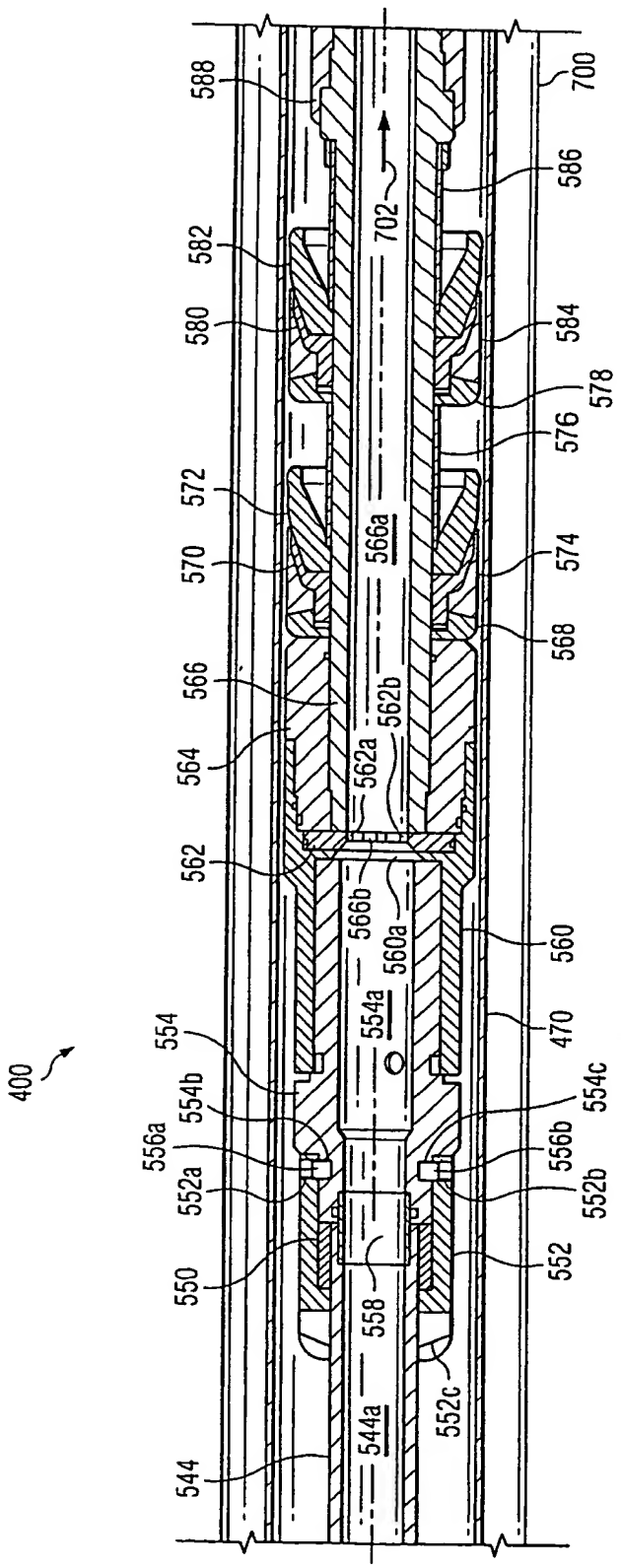
548b
540b
540
702
470
512
534a

Fig. 28g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562
554
554b
556a
552a
550
544
544a
558
552c
554a
566b
560a
562a
562b
566a
702
700
586
584
578
576
574
568
560
470
554c
556b
552b
552

Fig. 28h

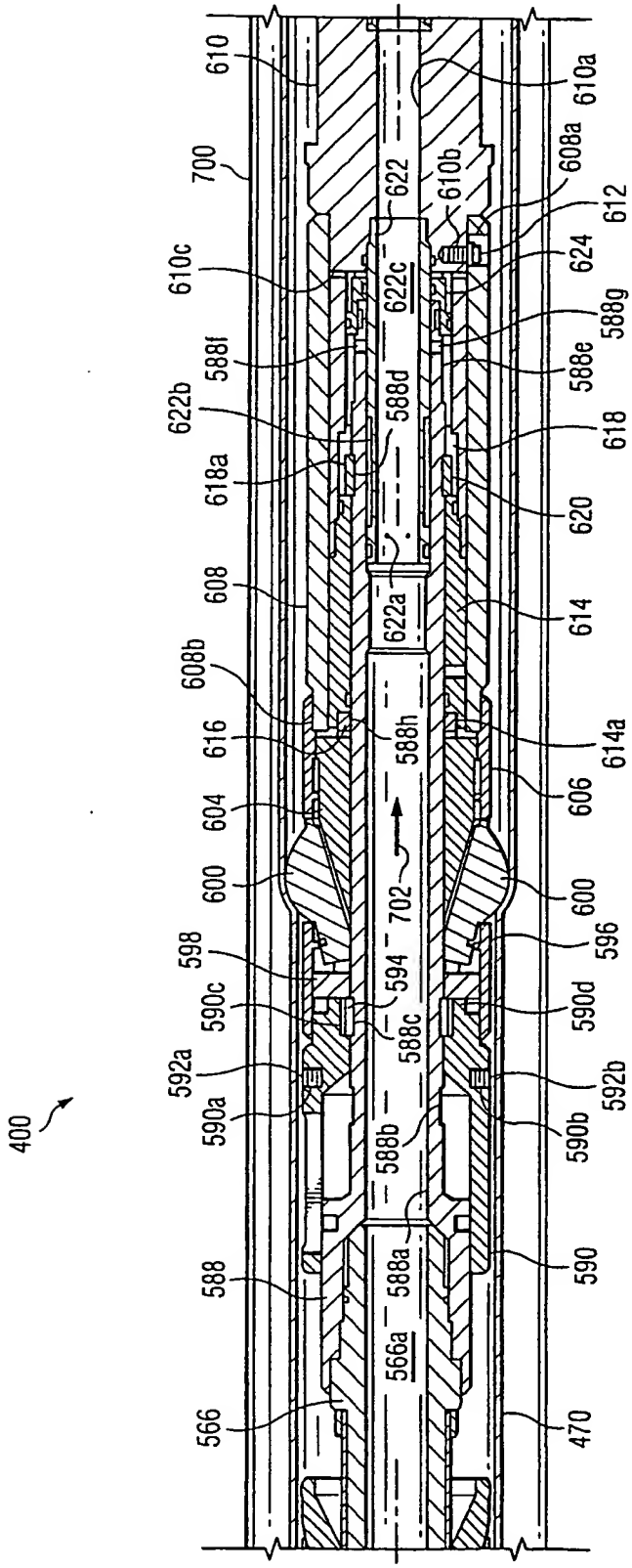

400
610
610a
700
608a
622
610b
612
610c
622c
624
588g
588f
588e
622b
588d
618
618a
620
608
622a
614
608b
588h
614a
616
606
604
600
702
600
598
596
594
590d
590c
588c
592a
592b
590a
590b
588b
588
588a
590
566a
566
470

Fig. 28i

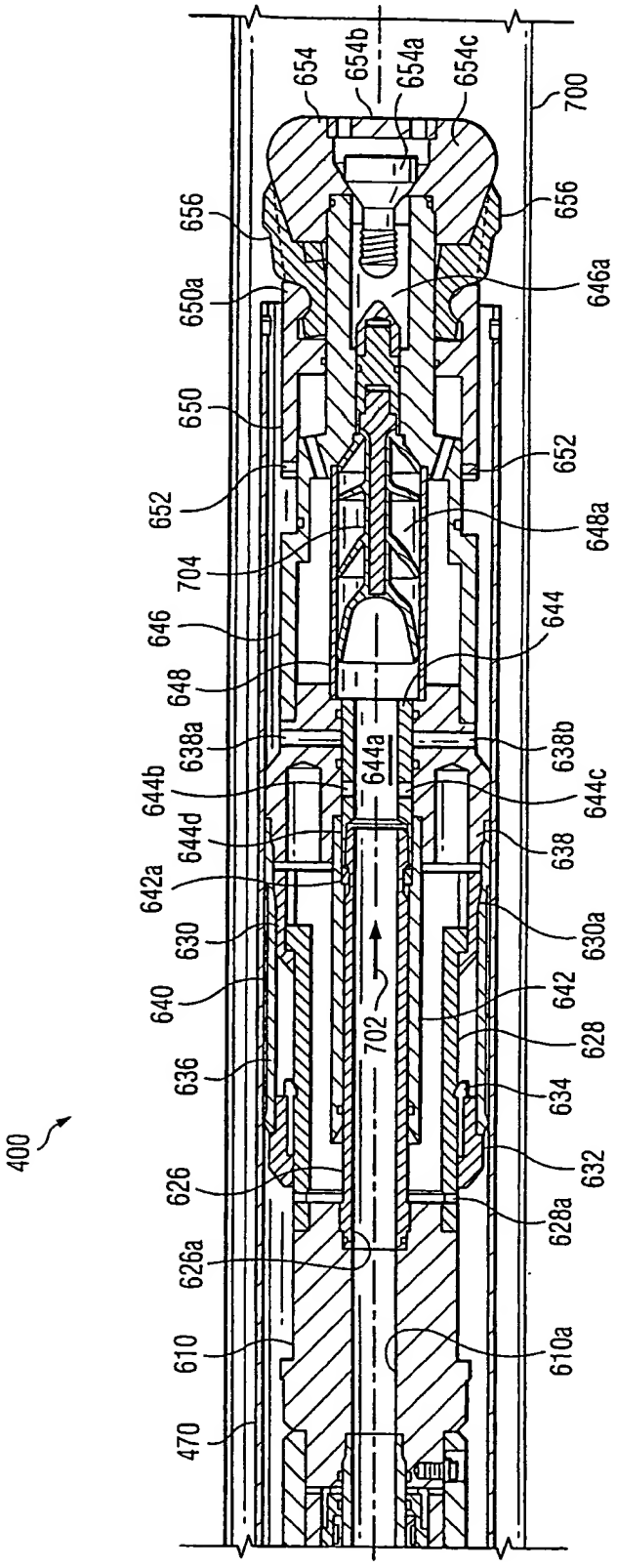

400
654
654b
654a
654c
700
656
656
650a
646a
650
652
652
652
648a
704
646
644
648
638a
644a
638b
644b
644c
644d
638
642a
630
630a
640
642
702
628
636
634
626
632
628a
626a
610
610a
470

Fig. 28j

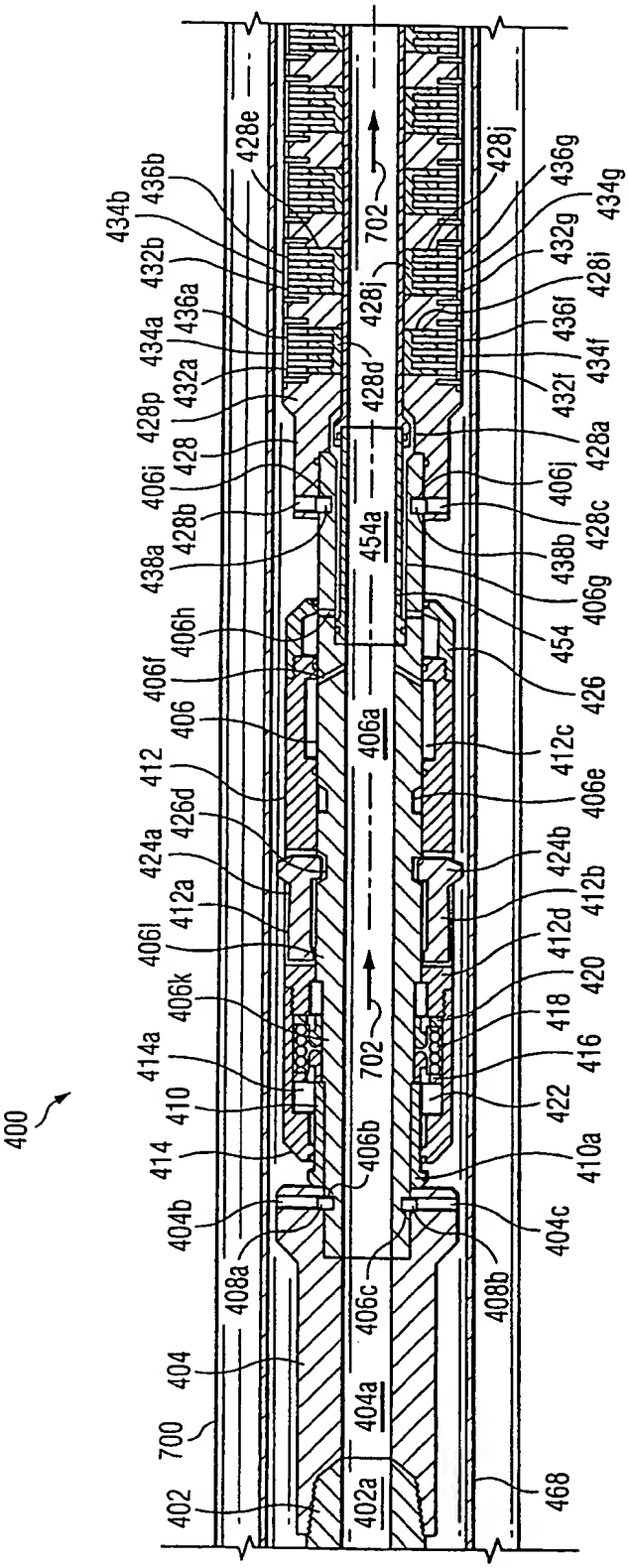

400
402
700
404
404a
402a
408a
404b
414
410
414a
406k
406l
412a
424a
426d
412
406
406f
406h
438a
428b
428
428p
406i
434a
432a
436a
432b
434b
436b
428e
406b
406c
406a
454a
702
428d
428i
428j
702
428j
436g
434g
432g
428i
436f
434f
432f
428a
406j
428c
438b
406g
454
426
412c
406e
424b
412b
412d
420
418
416
422
410a
404c
408b
468

Fig. 29a

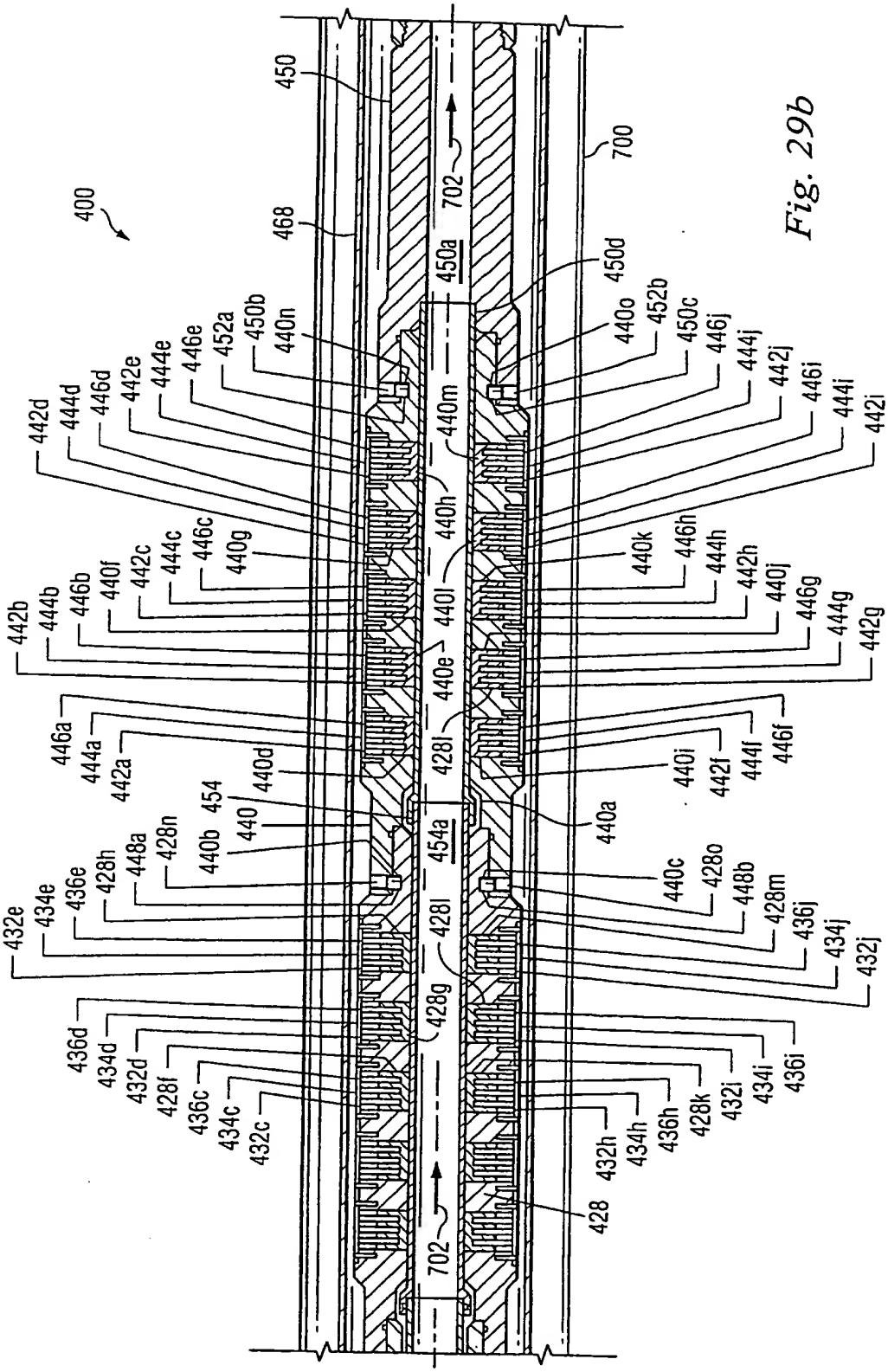

400
450
468
700
702
450a
450d
450b
440n
440o
452b
452a
450c
446e
444e
442e
446d
444d
442d
446j
444j
442j
446i
444i
442i
446c
444c
442c
446b
444b
442b
440f
440g
440h
440m
440k
446h
444h
442h
440j
446g
444g
442g
440l
440e
428l
446a
444a
442a
440d
440i
442f
444f
446f
454
440
440a
454a
428n
448a
428h
436e
434e
432e
440b
440c
428o
448b
428m
436j
434j
432j
428l
428g
436d
434d
432d
428l
436c
434c
432c
432h
434h
436h
428k
432i
434i
436i
428
702

Fig. 29b

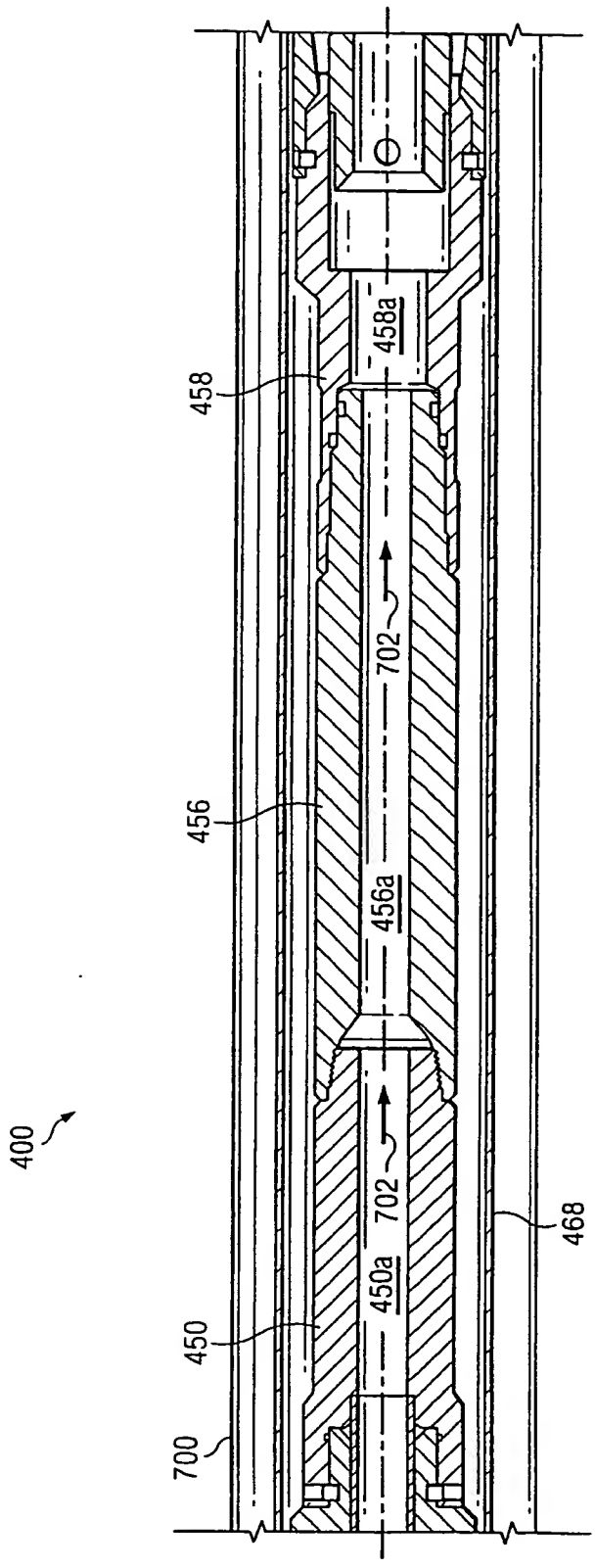


Fig. 29c

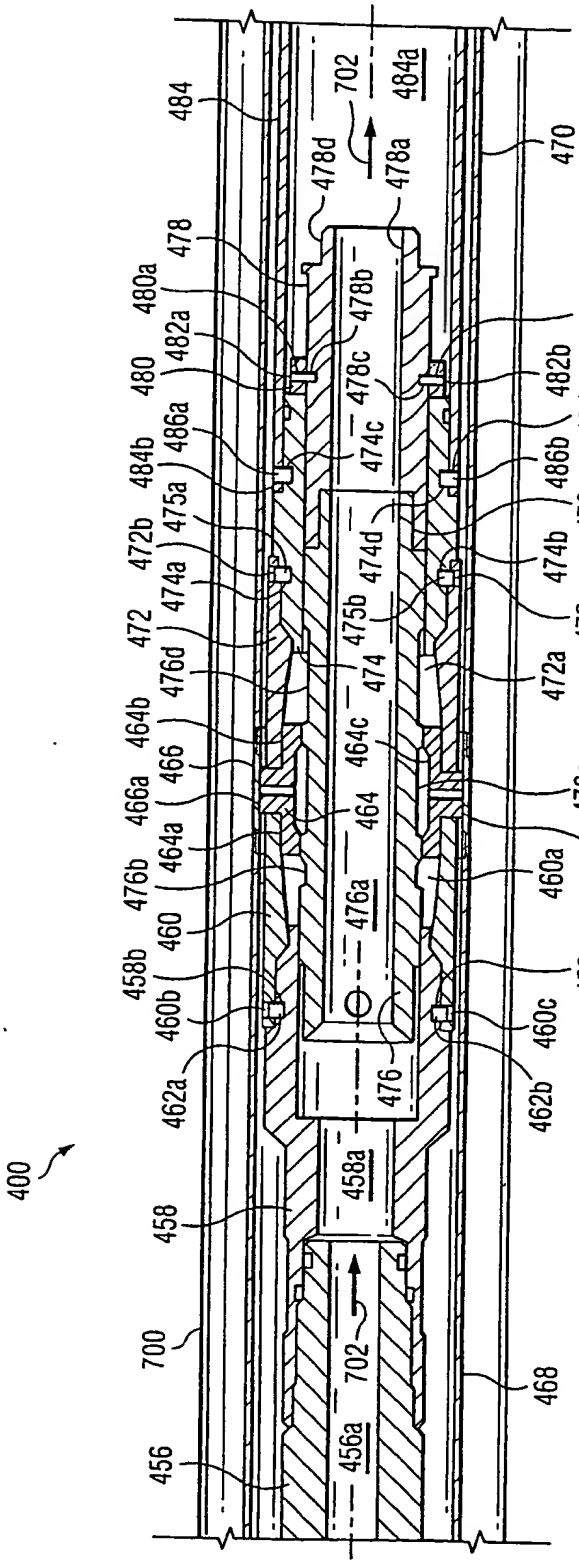

400
456
456a
458
458a
458b
458c
460
460a
460b
460c
462a
462b
464
464a
464b
464c
464d
466
466a
468
470
472
472a
472b
472c
474
474a
474b
474c
474d
475a
475b
476
476a
476b
476c
476d
476e
478
478a
478b
478c
478d
480
480a
480b
482a
482b
484
484a
484b
484c
486a
486b
700
702

Fig. 29d

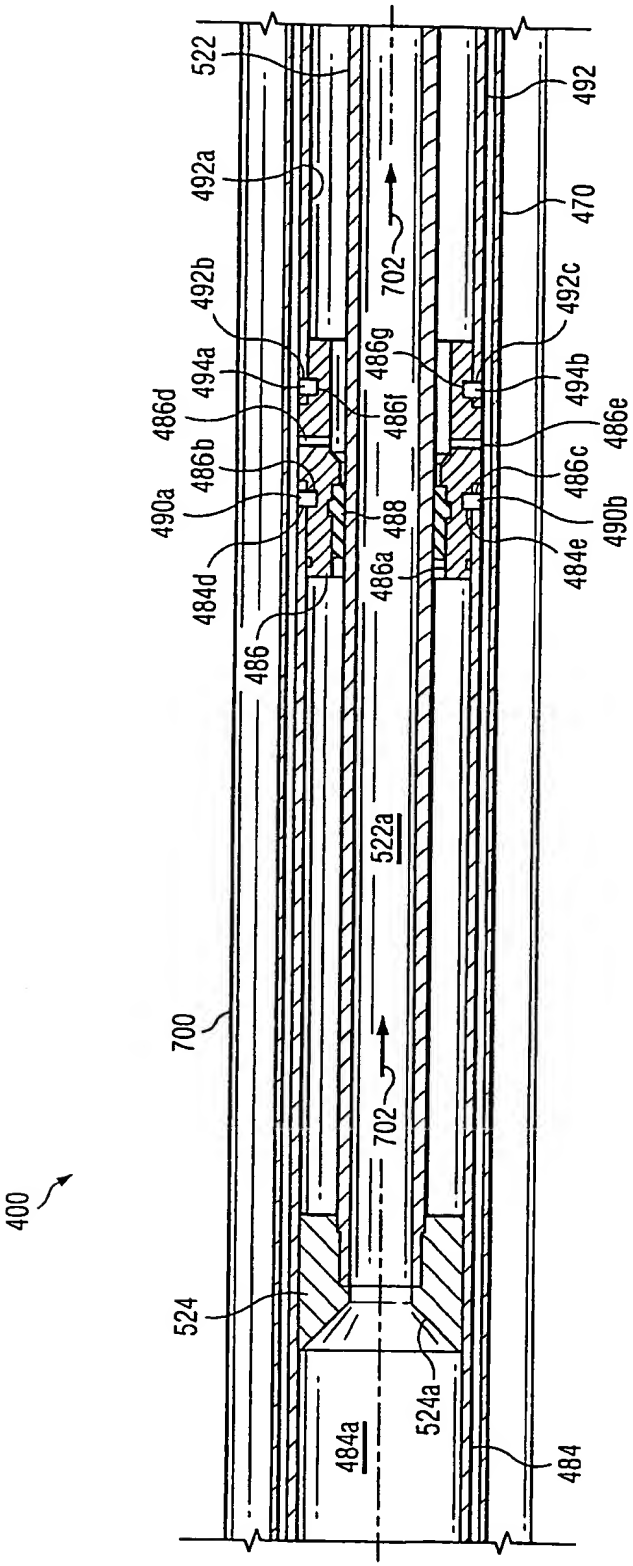

400
522
492a
492b
494a
486d
486b
490a
484d
486
700
524
484a
524a
484
522a
702
702
492
470
492c
494b
486e
486c
490b
484e
486a
488
486f
486g

Fig. 29e

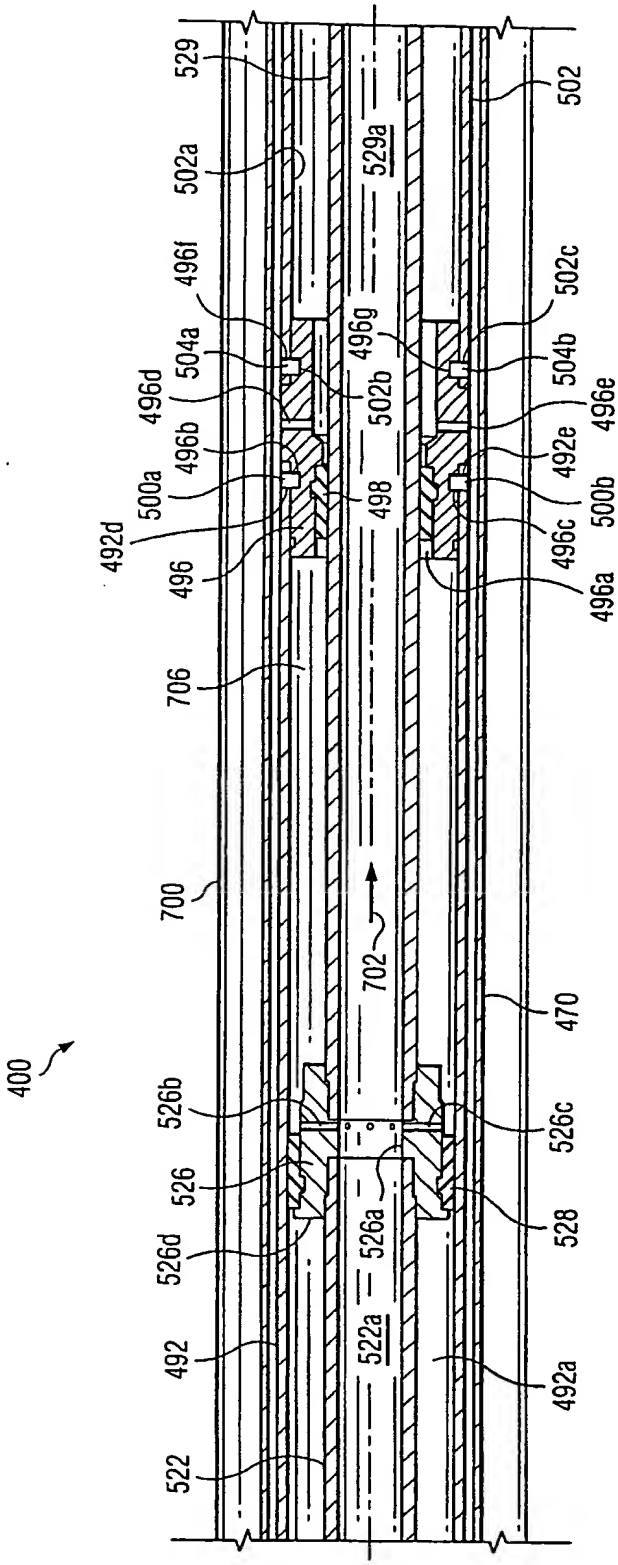

400
529
502
502a
529a
496f
502c
504a
496g
504b
496d
502b
496e
496b
492e
500a
498
500b
492d
496c
496
496a
706
700
702
470
526b
526c
526
528
526a
526d
522a
492
492a
522

Fig. 29f

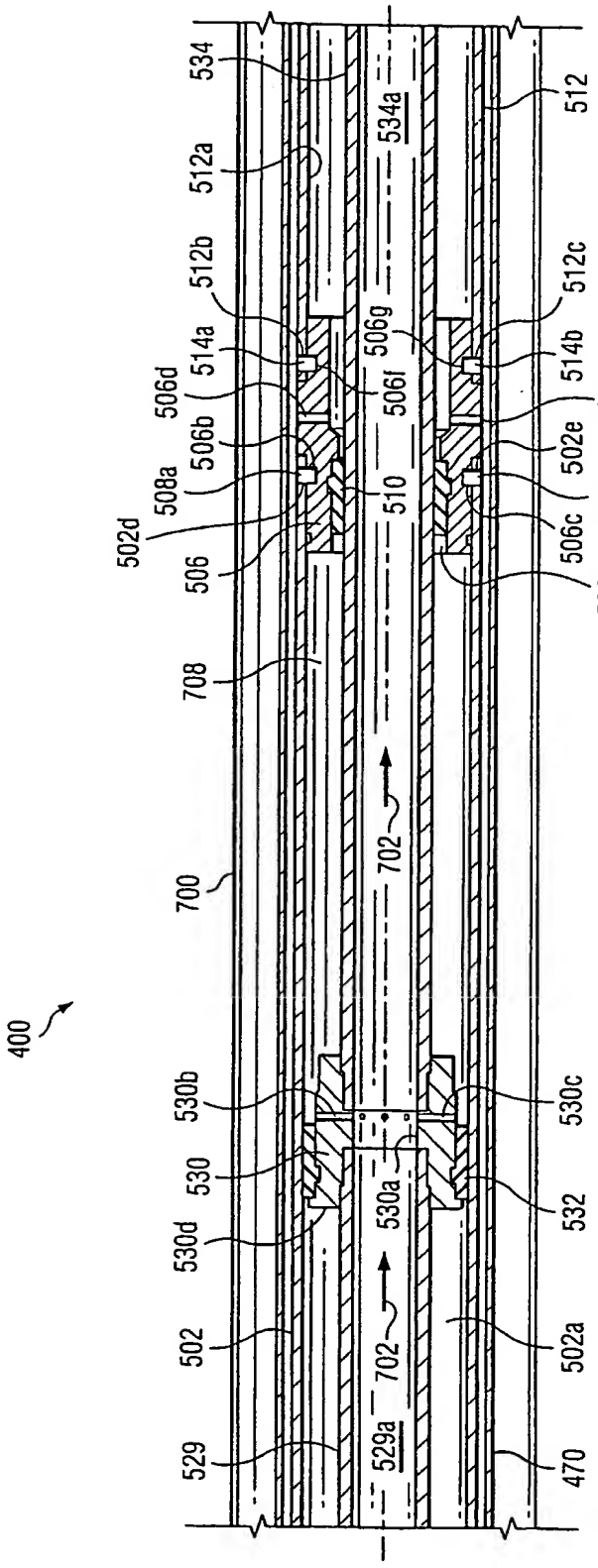

400
529
529a
502
530d
530
530b
700
708
502d
506
508a
506b
506d
514a
512b
512a
534
534a
512
512c
514b
506e
502e
508b
506c
506a
506f
506g
510
702
530a
530c
532
502a
470

Fig. 29g

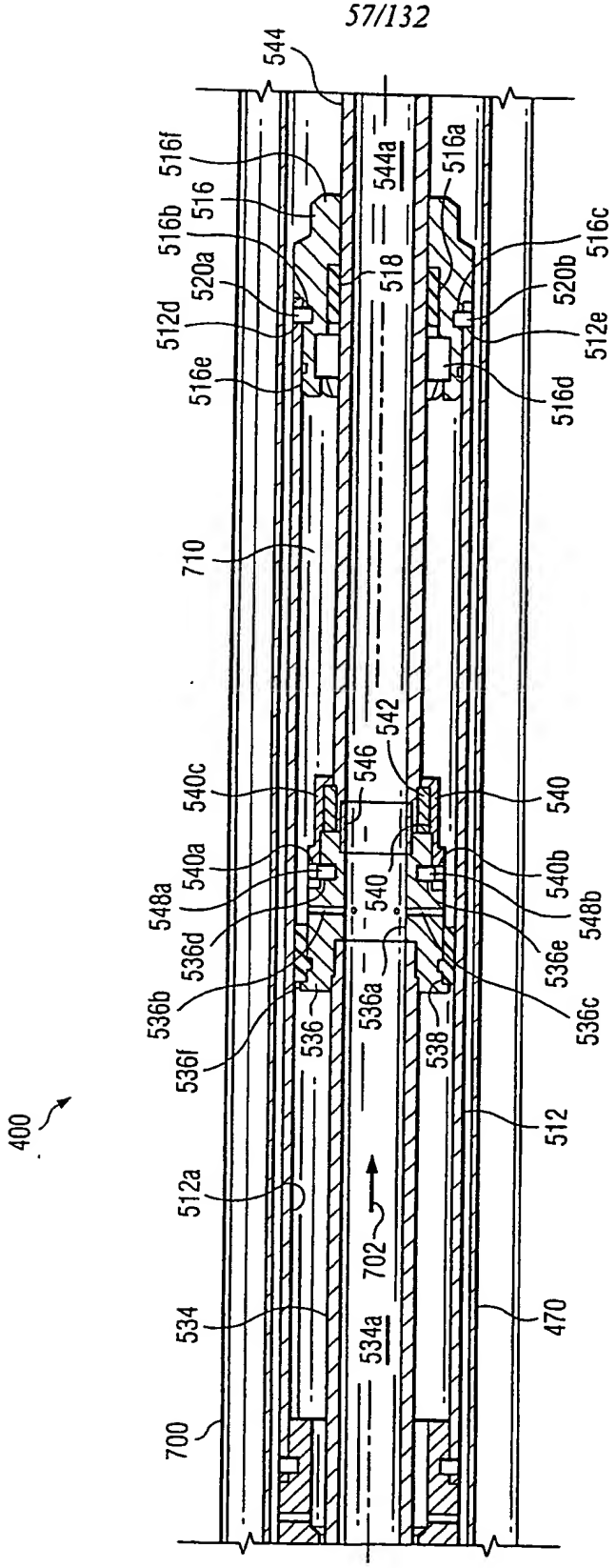

400
544
516f
516b
516
520a
512d
516e
710
544a
516a
516c
520b
512e
516d
518
542
546
540c
540a
548a
536d
536b
536f
536
536a
538
540
540b
548b
536e
536c
512
512a
702
534
534a
700
470

Fig. 29h

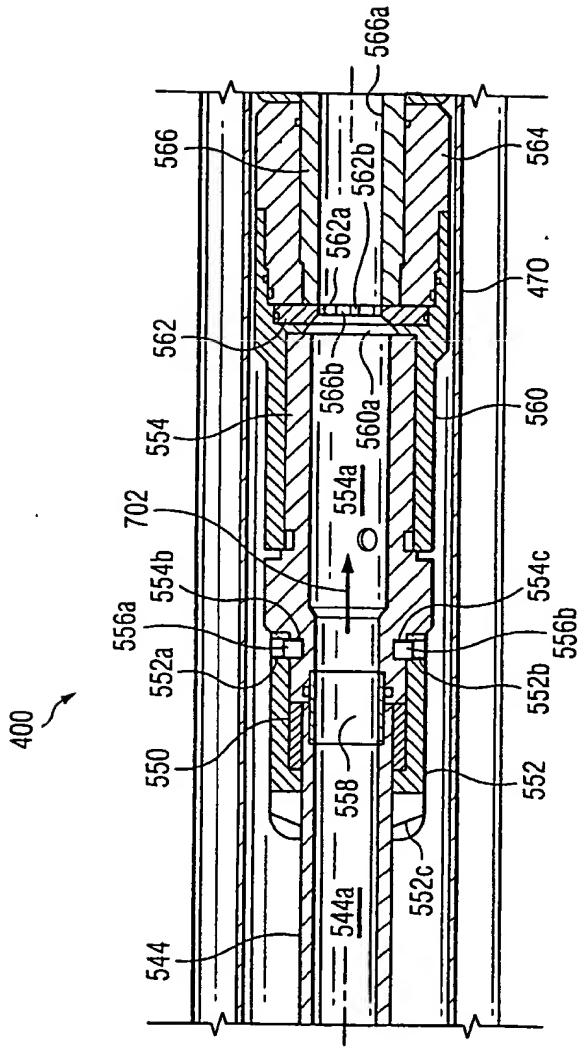

400
566a
566
562b
564
562a
470
562
566b
560a
560
554
554a
702
554b
554c
556a
556b
552a
552b
550
558
552
552c
544a
544

Fig. 29i

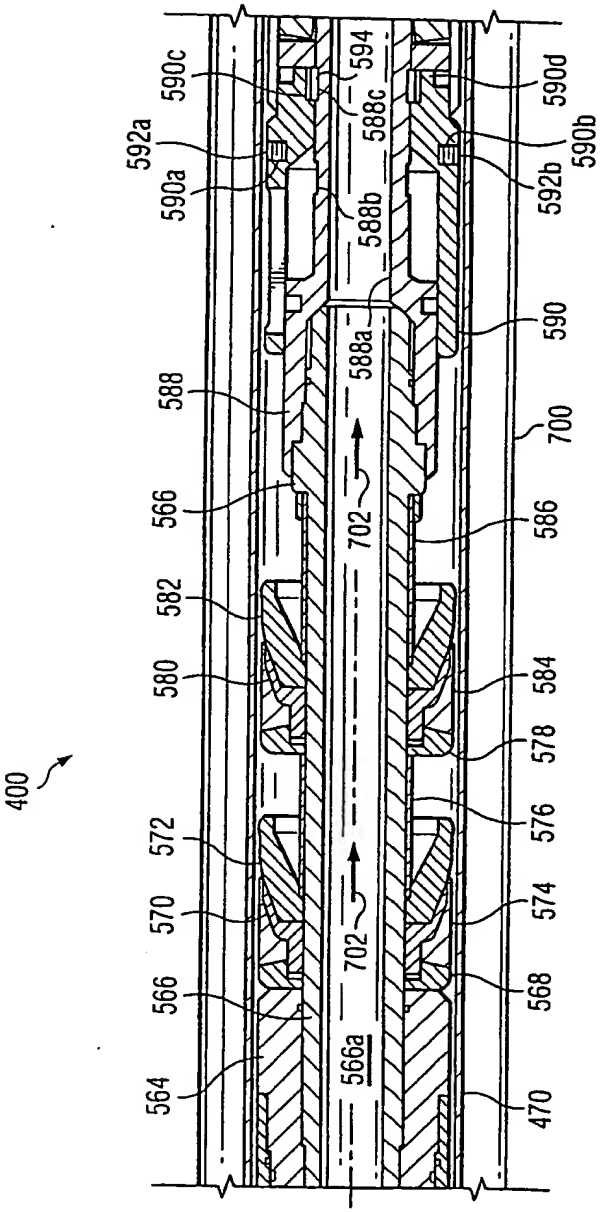

400
590c
592a
590a
588
566
582
580
572
570
566
564
594
588c
588b
588a
702
702
566a
590d
590b
592b
590
700
586
584
578
576
574
568
470

Fig. 29j

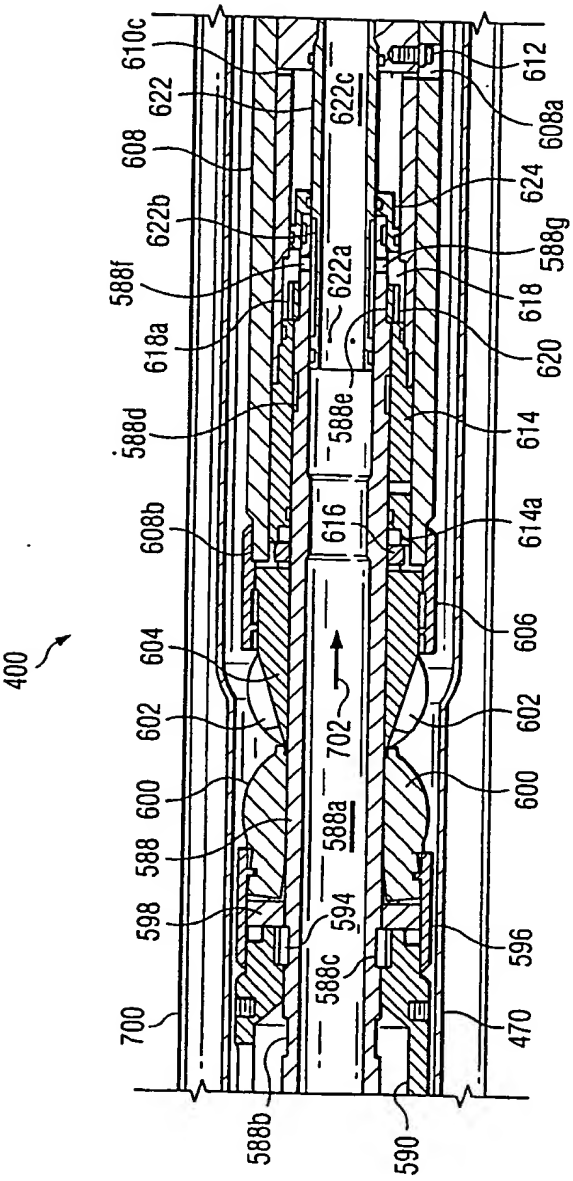

400
610c
622
608
622b
588f
618a
588d
608b
604
602
600
588
598
700
588b
622c
622a
588e
616
702
588a
594
588c
590
612
608a
624
588g
618
620
614
614a
606
602
600
596
470

Fig. 29k

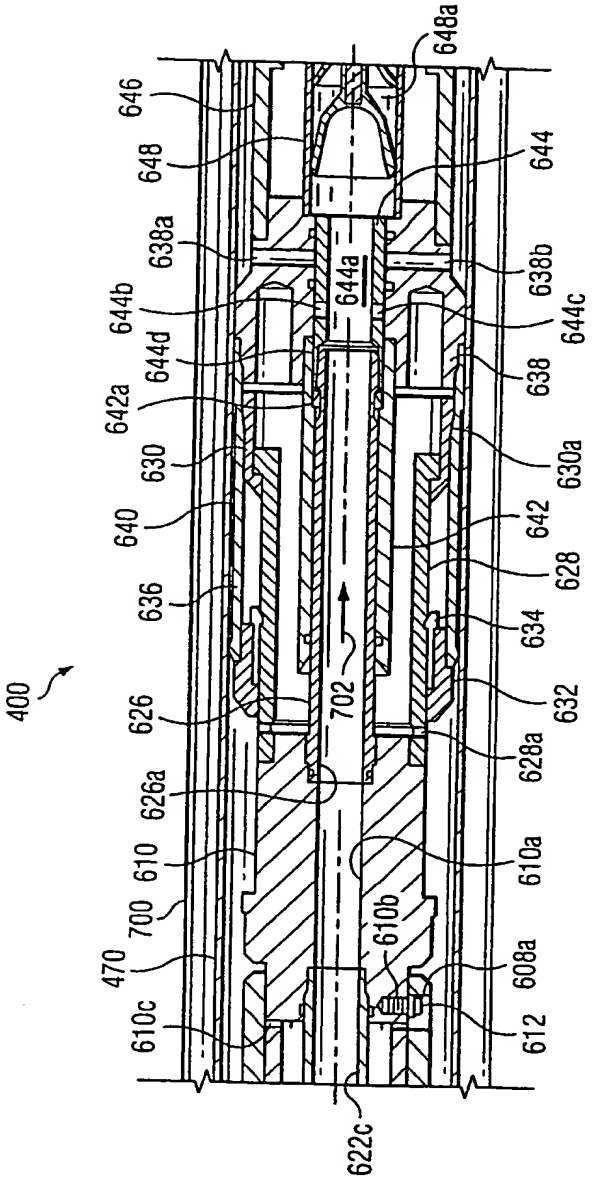

400
470
610c
700
610
626a
626
636
640
630
642a
644d
644b
638a
646
648
648a
644
644a
638b
644c
638
630a
642
628
634
632
628a
610a
610b
608a
612
622c
702

Fig. 29l

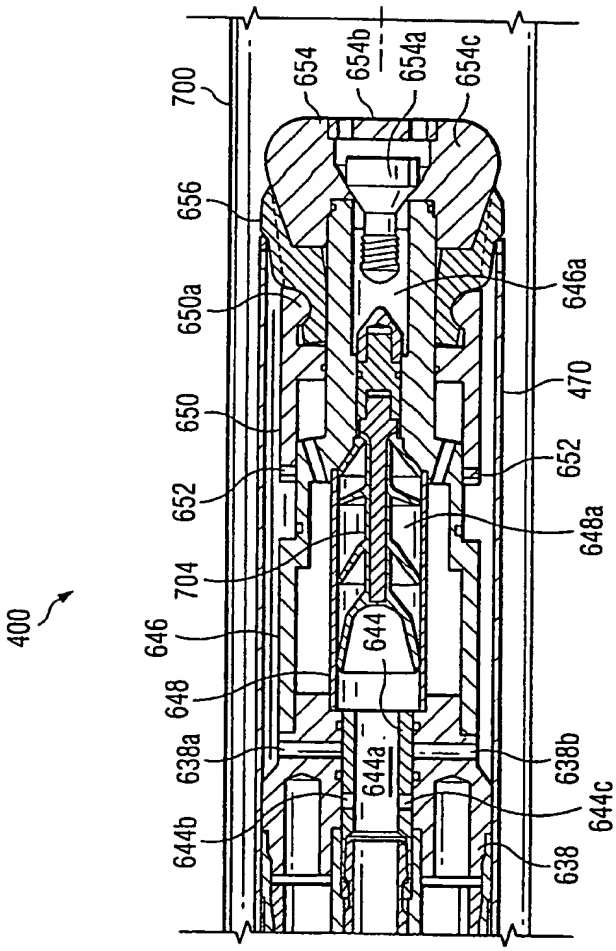

400
700
654
654b
654a
654c
656
650a
646a
470
650
652
652
648a
704
646
644
648
638a
644a
638b
644c
644b
638

Fig. 29m

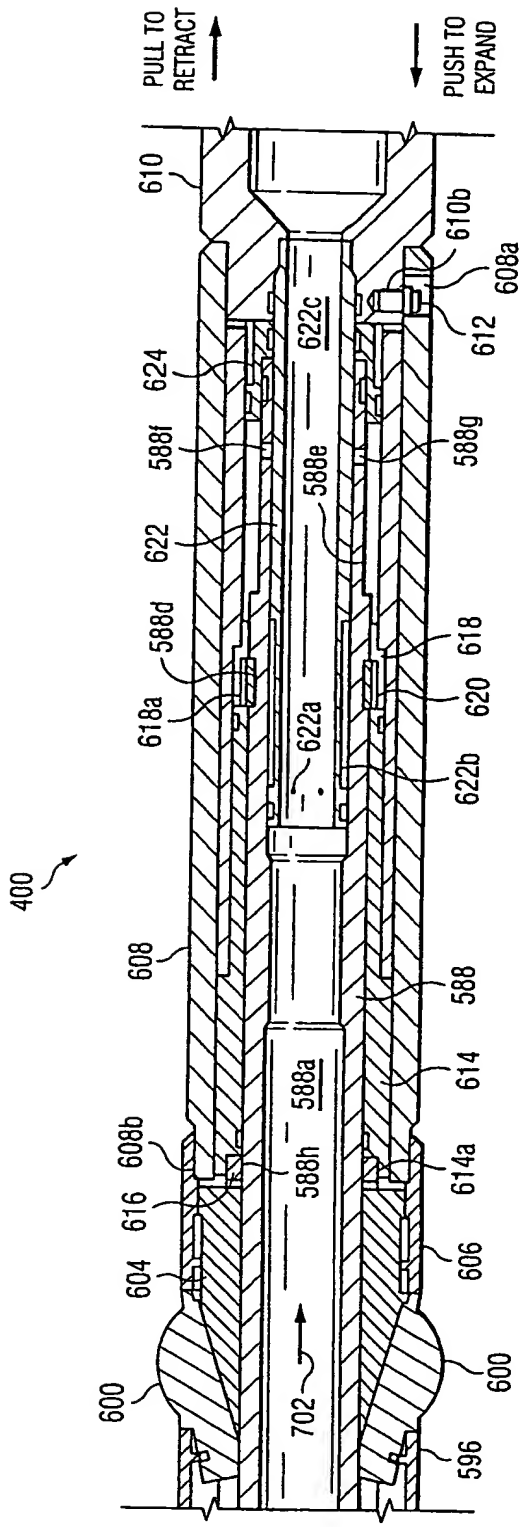

PULL TO RETRACT
PUSH TO EXPAND
610
610b
608a
612
622c
624
588f
588e
588g
622
588d
618
618a
620
622a
622b
400
608
588
588a
614
608b
588h
614a
616
606
604
600
600
702
596

Fig. 30a

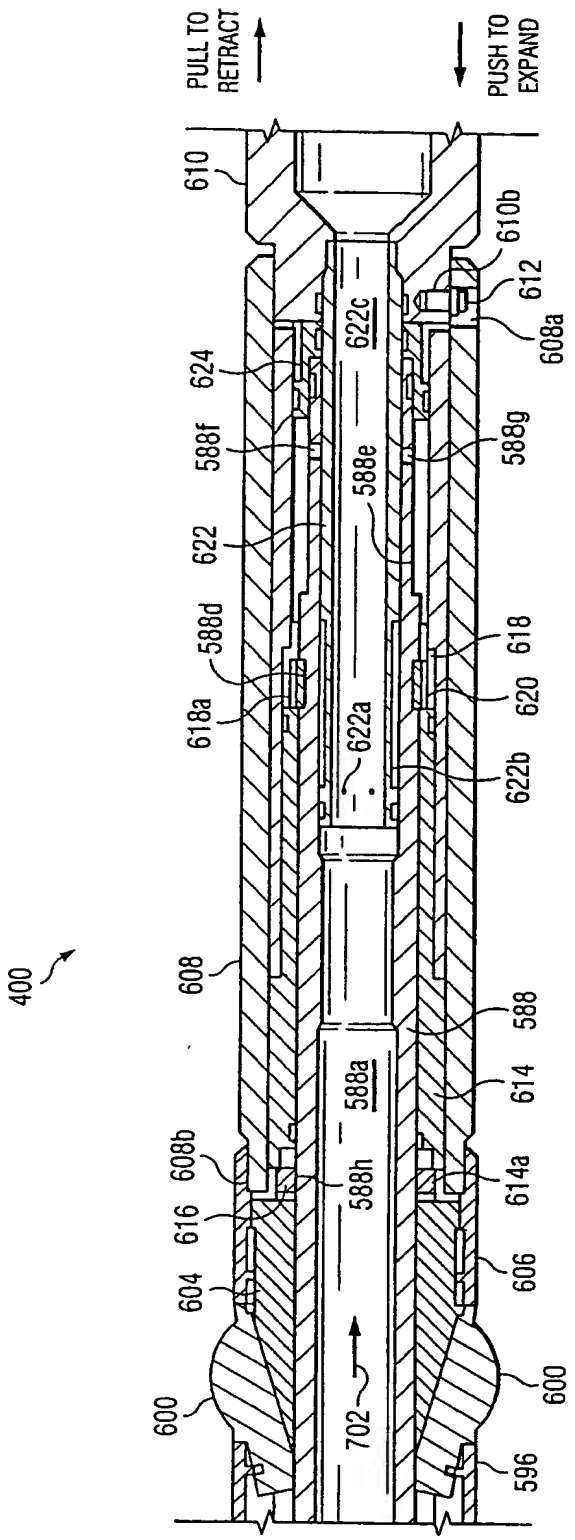

PULL TO RETRACT
PUSH TO EXPAND
400
610
610b
612
608a
624
622c
588f
588e
588g
622
588d
618
618a
620
622a
622b
608
588
588a
614
608b
588h
614a
616
606
604
600
702
600
596

Fig. 30b

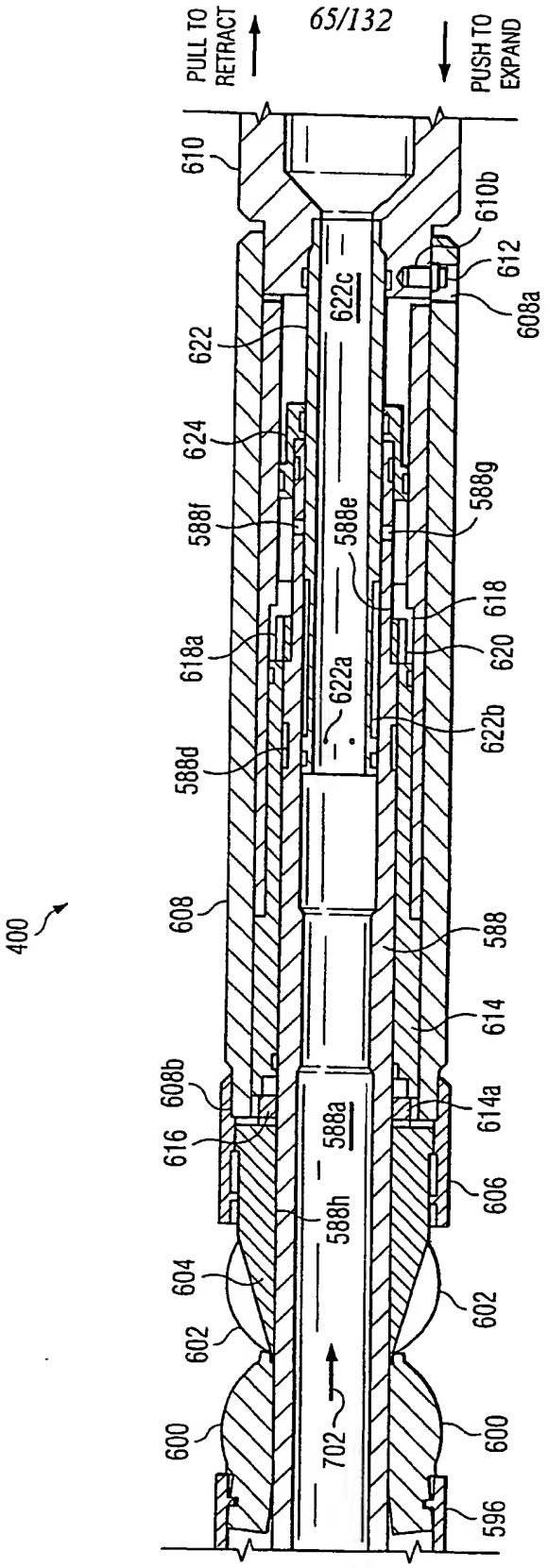

PULL TO RETRACT
PUSH TO EXPAND
400
610
610b
612
608a
622
622c
624
588f
588e
588g
618
618a
620
622a
622b
588d
608
588
614
608b
614a
616
588a
606
588h
604
602
602
600
600
702
596

Fig. 30c

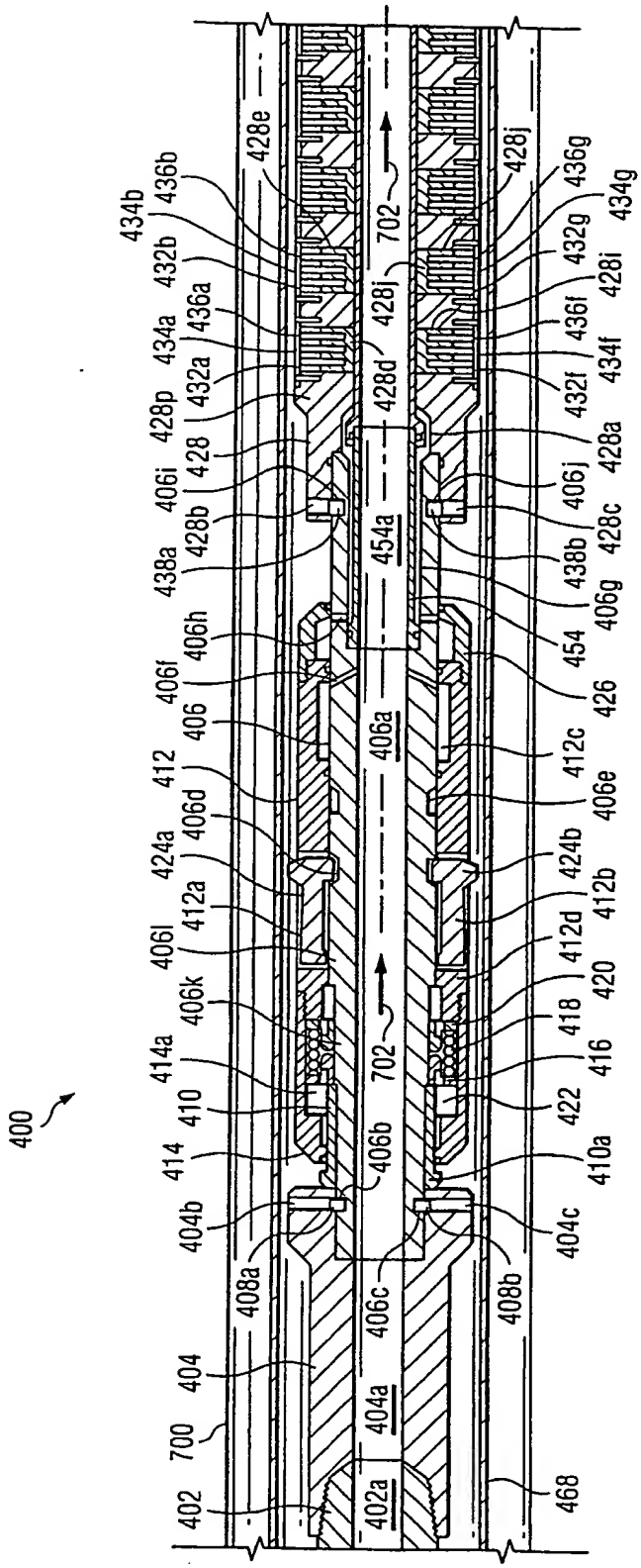

400
402
700
404
404a
402a
468
408a
408b
404b
404c
414
410
410a
414a
422
406b
406c
702
416
418
420
406k
406l
412a
412d
412b
424a
424b
406d
412
406a
412c
406e
406
406f
406h
426
454
406g
438a
438b
428b
428c
454a
406i
406j
428
428a
428p
428d
432a
432f
434a
434f
436a
436f
432b
432g
436b
436g
434b
434g
428e
428i
428j
702

Fig. 31a

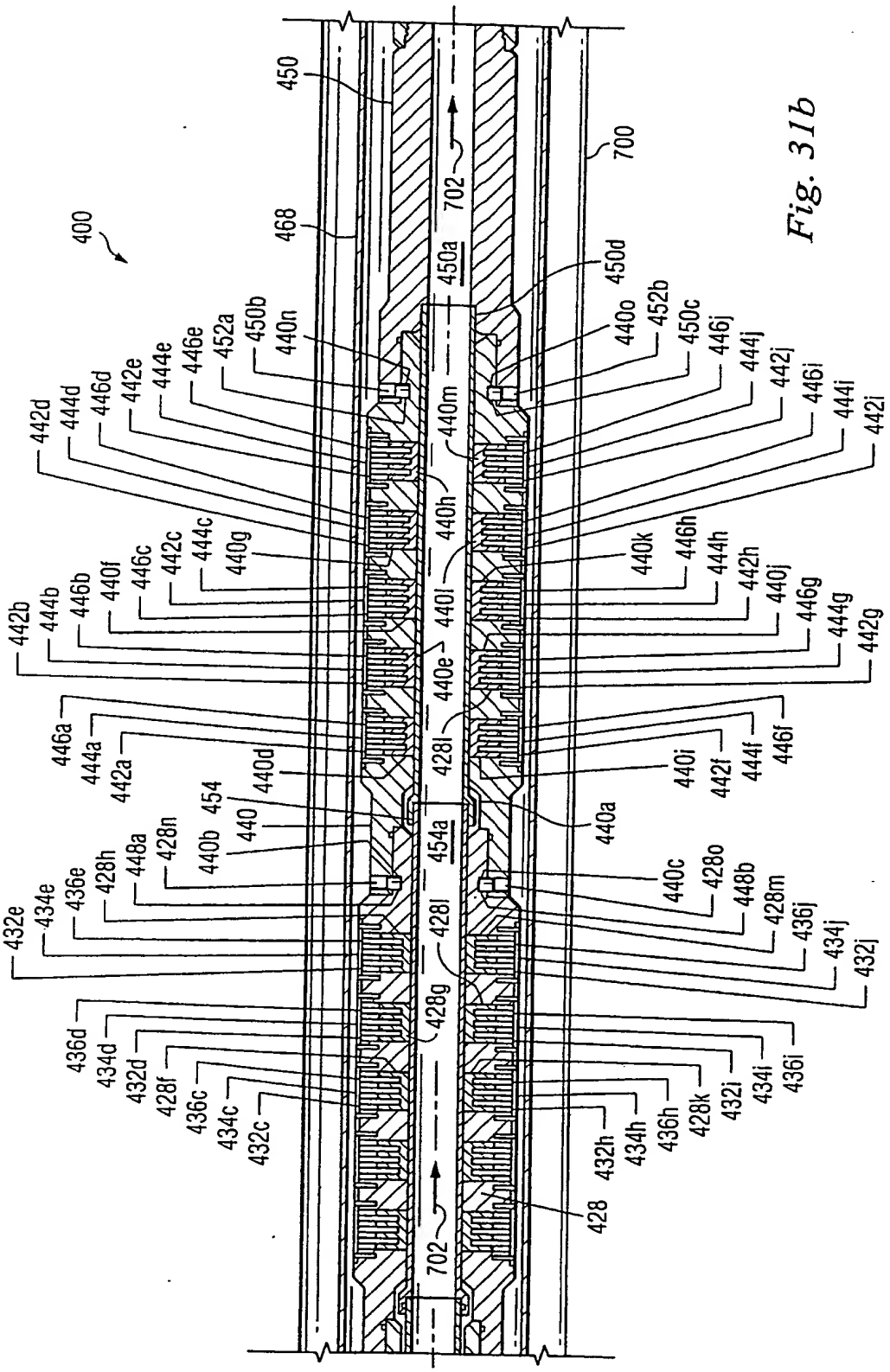

400
450
468
700
702
450a
450d
452b
450c
446j
444j
442j
446i
444i
442i
440o
452a
450b
440n
444e
446e
442e
446d
444d
442d
440m
440h
440k
446h
444h
442h
440j
446g
444g
442g
440l
440e
440g
444c
442c
446c
440f
446b
444b
442b
428l
446a
444a
442a
440d
454
440
440b
448a
428n
428h
436e
434e
432e
454a
440a
440i
442f
444f
446f
440c
428o
448b
428m
436j
434j
432j
428g
436d
434d
432d
428f
436c
434c
432c
428
432h
434h
436h
428k
432i
434i
436i
702

Fig. 31b

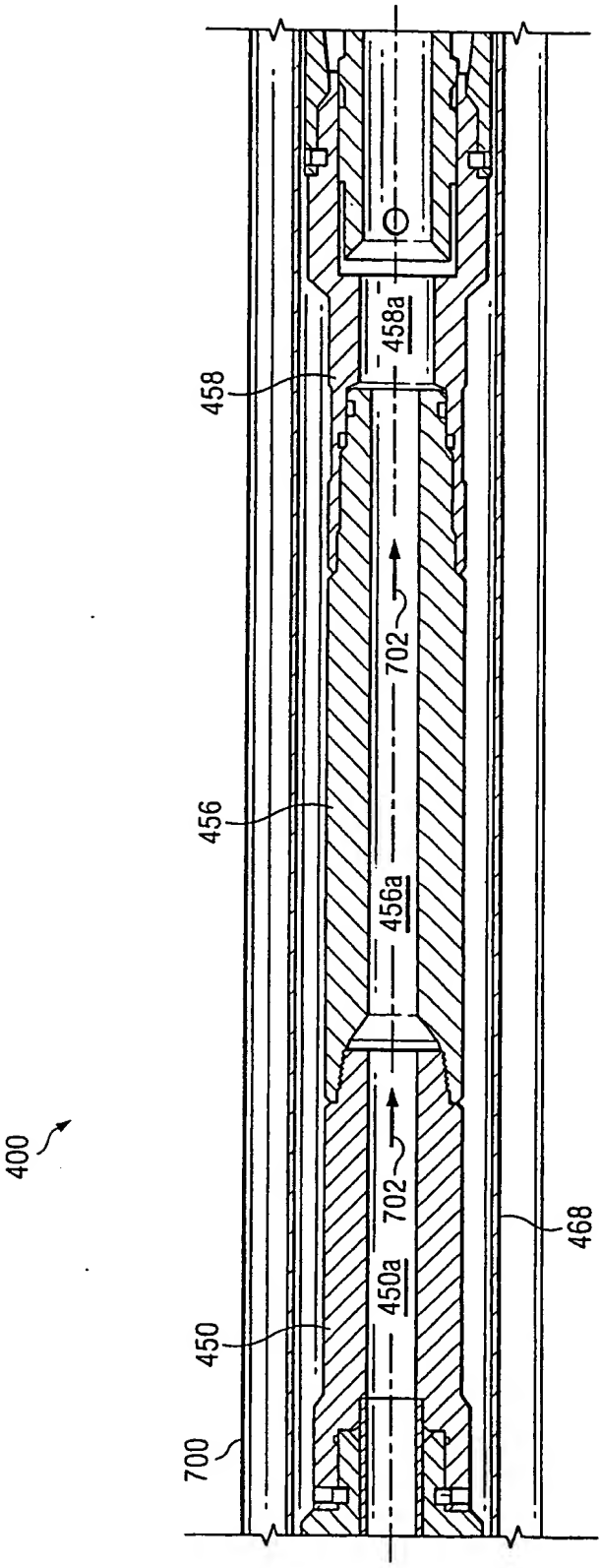


Fig. 31c

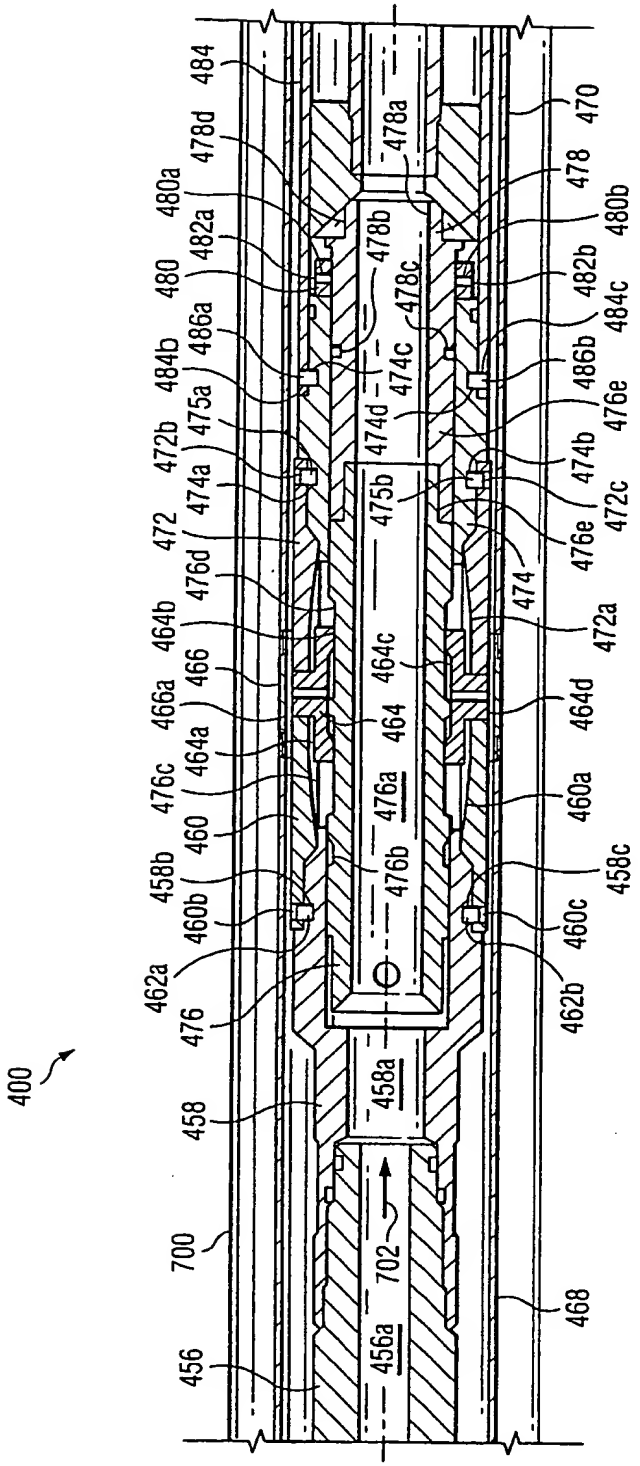

400
456
456a
700
702
458
458a
462a
476
462b
458b
460b
460
476c
464a
466
466a
464b
476d
472
474a
475a
472b
484b
486a
480
482a
478d
484
480a
458c
460c
460a
464d
472a
474
476e
472c
474b
476e
486b
484c
482b
480b
478
470
478a
478b
478c
474c
474d
475b
464c
464
476a
476b
468

Fig. 31d

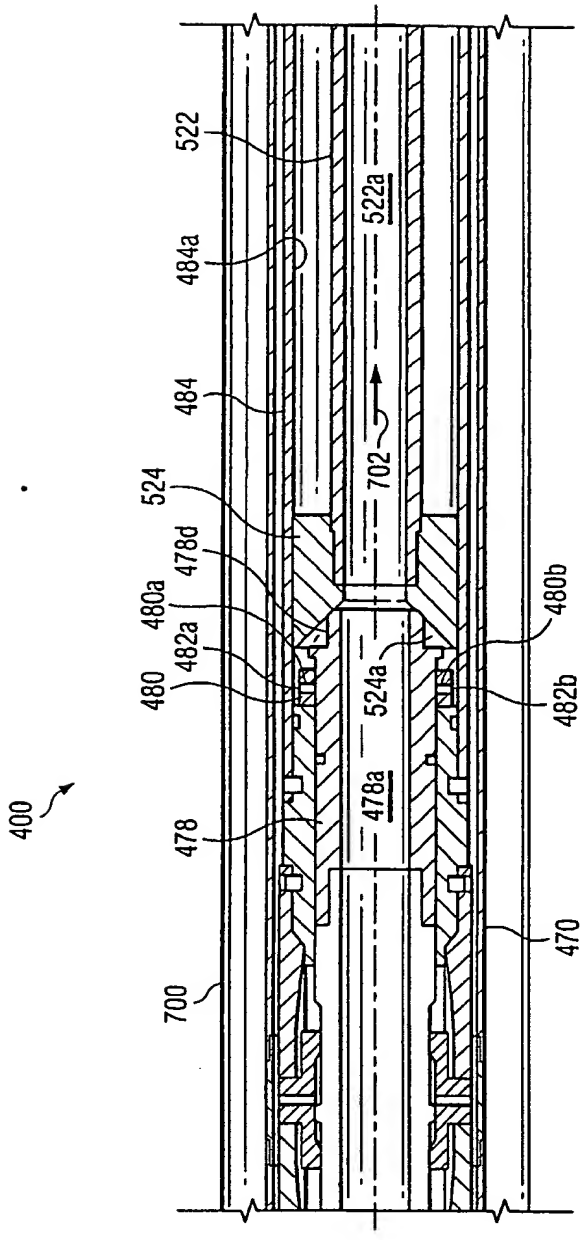

400
522
522a
484a
484
702
524
478d
480a
482a
480
524a
480b
482b
478a
478
470
700

Fig. 31e

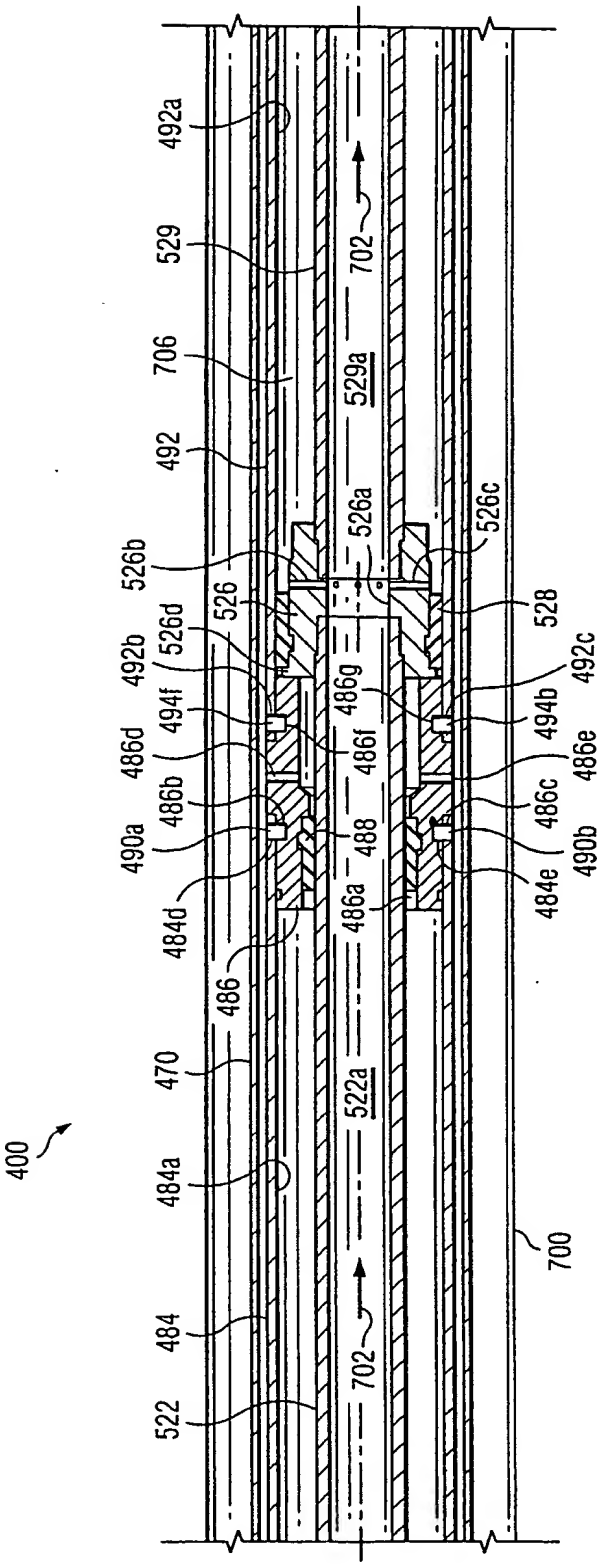

400
492a
529
706
492
526b
526
526d
492b
494f
486d
486b
490a
484d
486
470
484a
484
522
522a
702
529a
526a
526c
528
492c
494b
486e
486c
490b
484e
486a
488
486f
486g
700

Fig. 31f

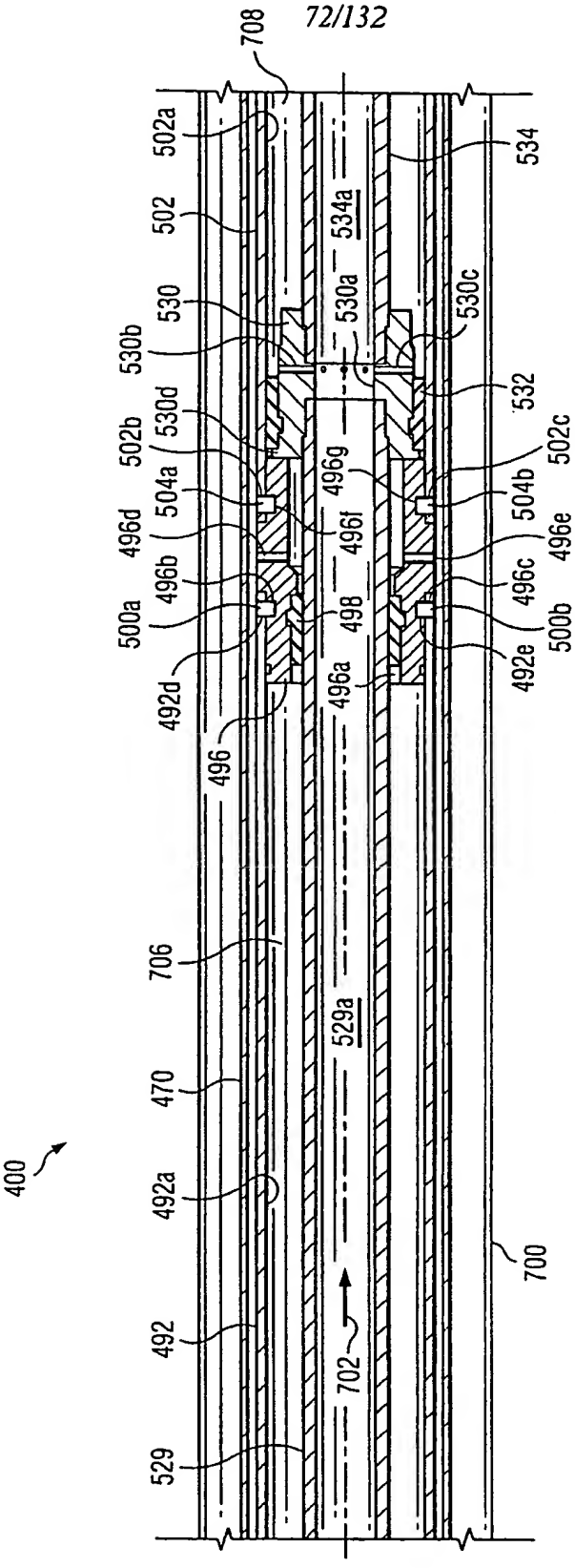

400
708
502a
502
530
530b
502b
530d
504a
496d
496b
500a
492d
496
706
470
492a
492
529
529a
702
534
534a
530a
530c
532
502c
504b
496e
496c
500b
492e
496a
498
496f
496g

Fig. 31g

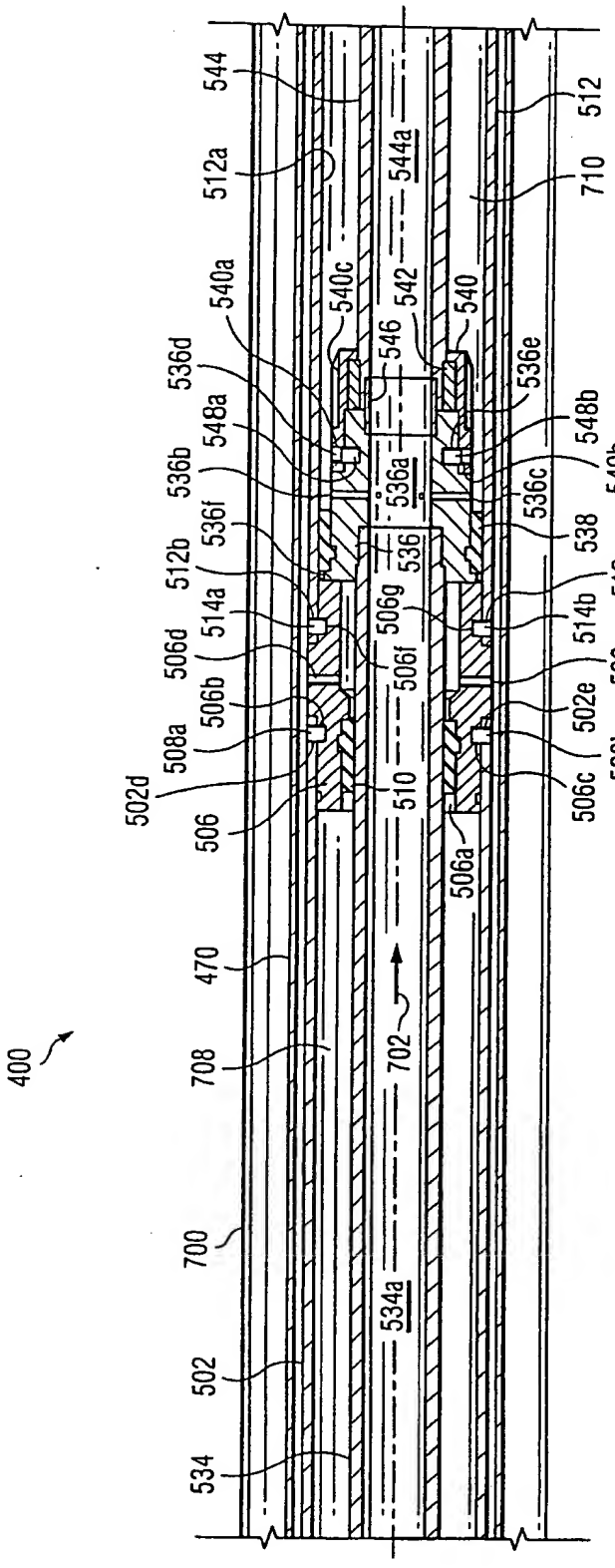

400
534
502
534a
700
708
470
702
506
502d
508a
506b
506d
514a
512b
536f
536b
548a
536d
540a
544
512a
544a
540c
542
546
540
536e
548b
540b
536c
538
512c
514b
506e
502e
508b
506c
506a
710
512
536
536a
506g
506f
510

Fig. 31h

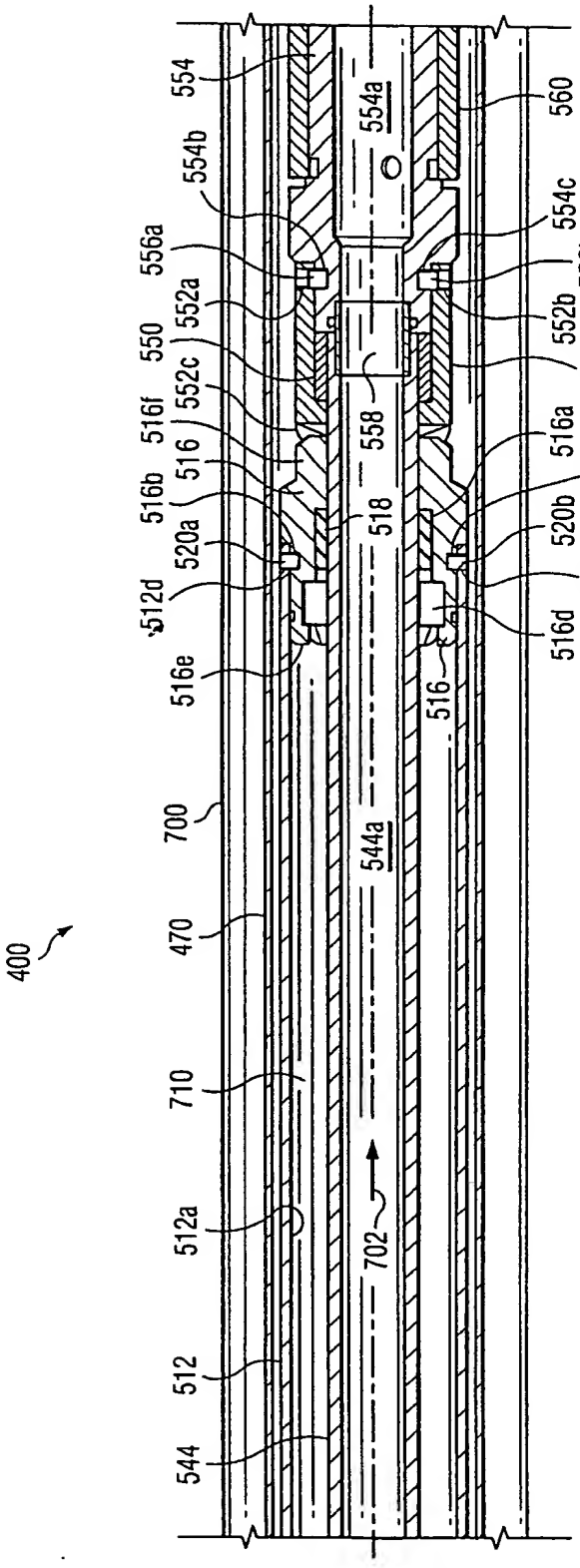

400
544
512
512a
710
470
700
544a
516e
512d
516b
520a
516f
516
552c
552a
550
556a
554b
554
554a
560
554c
556b
552b
552
516a
516c
520b
512e
516d
516
558
518
702

Fig. 31i

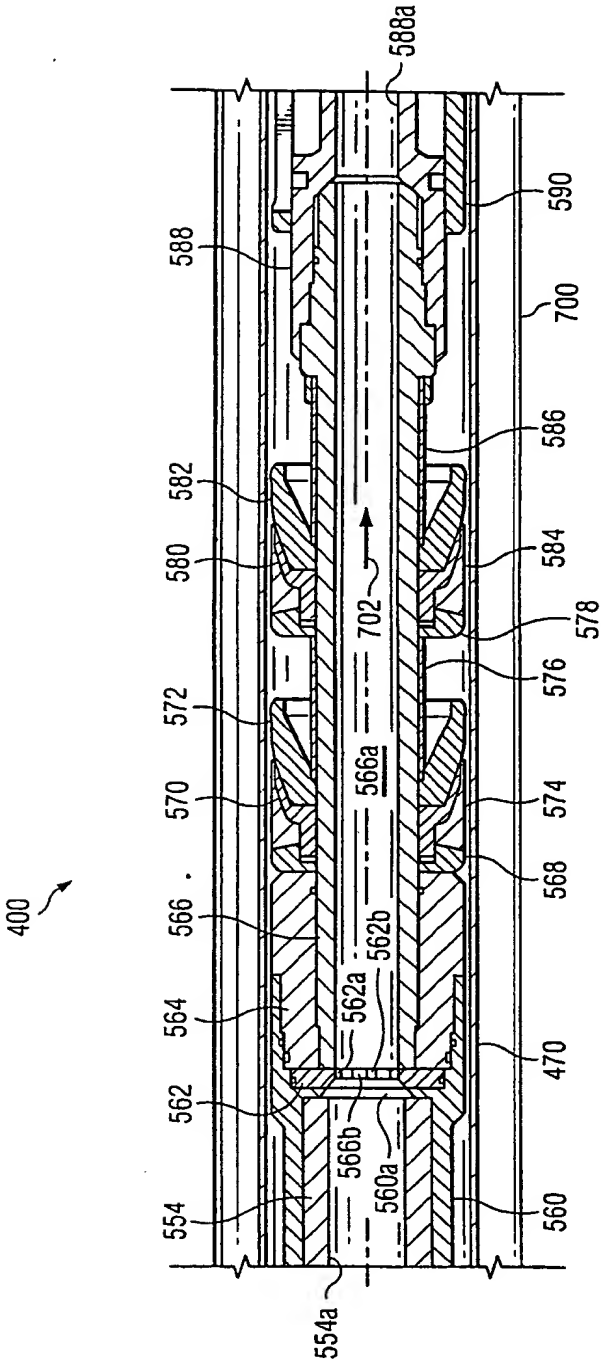

400
554
554a
562
564
566
570
572
580
582
588
588a
590
700
586
584
578
576
574
568
470
560
560a
566b
562b
562a
566a
702

Fig. 31j

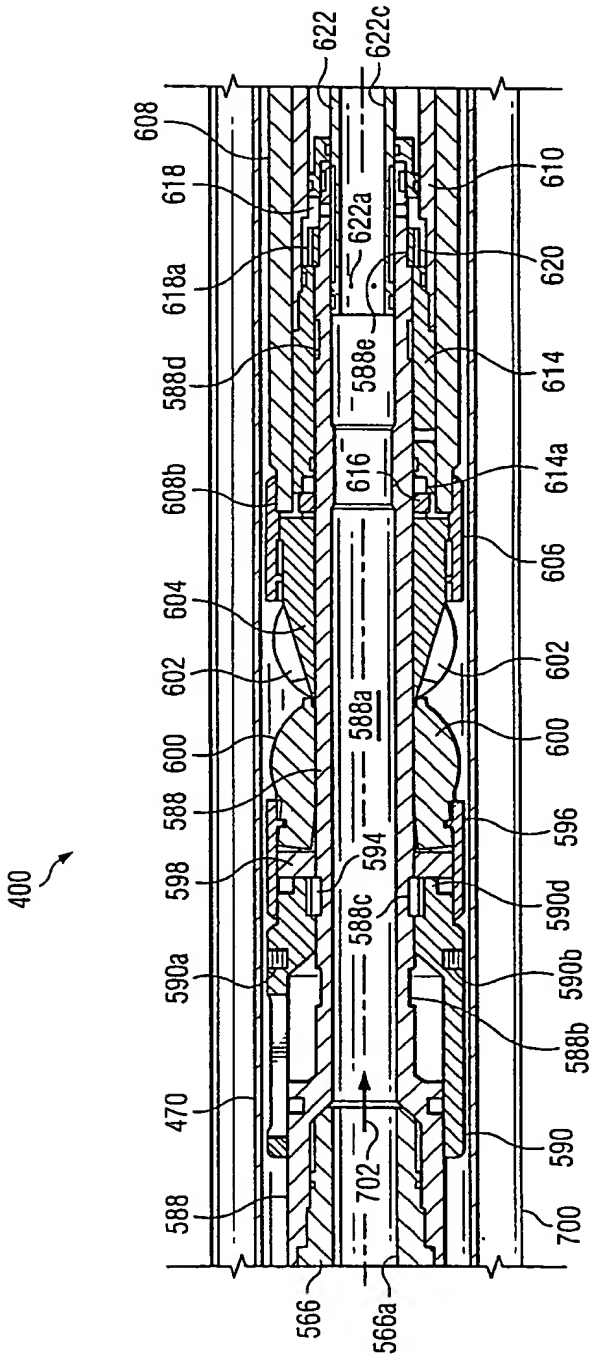

400
608
618
618a
588d
608b
604
602
600
588
598
590a
470
588
622
622c
622a
588e
616
588a
594
588c
702
566
566a
610
620
614
614a
606
602
600
596
590d
590b
588b
590
700

Fig. 31k

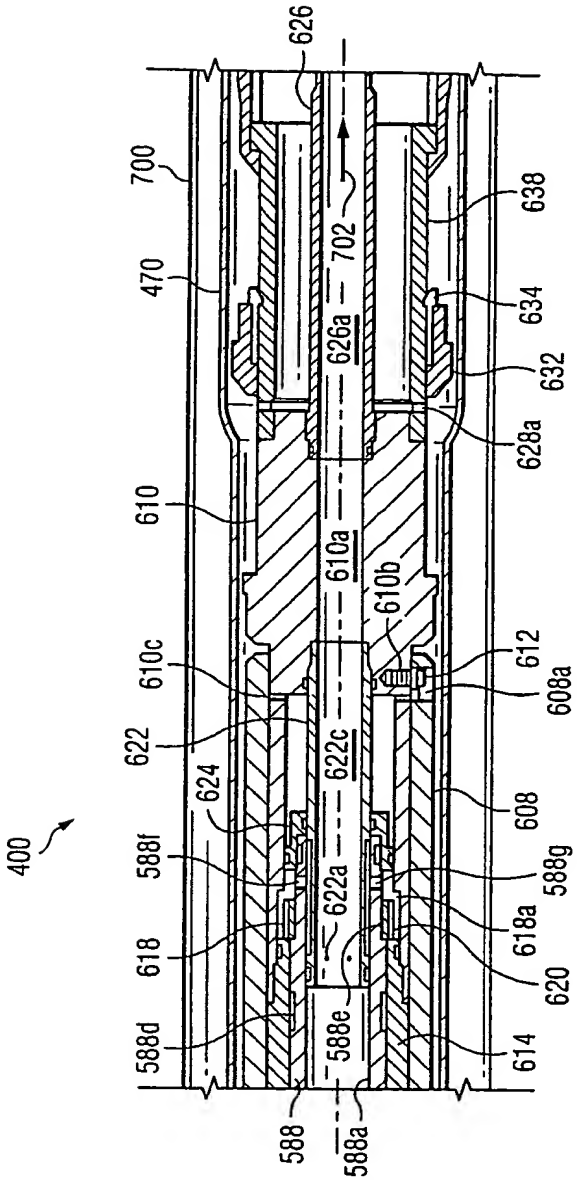

400
626
700
470
610
610c
622
624
588f
618
588d
588
588a
588e
622a
622c
610a
610b
626a
702
638
634
632
628a
612
608a
608
588g
618a
620
614

Fig. 311

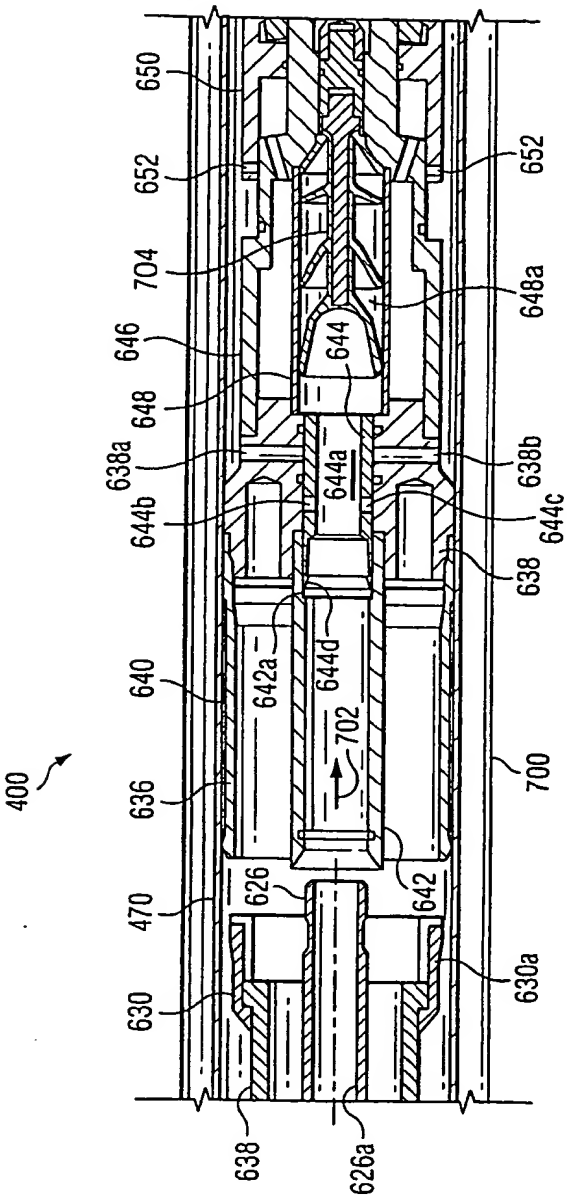

400
650
652
704
646
648
638a
644b
640
636
470
630
638
626a
626
642a
644d
702
644
644a
642
638a
638b
644c
638
700
630a
652
648a

Fig. 31m

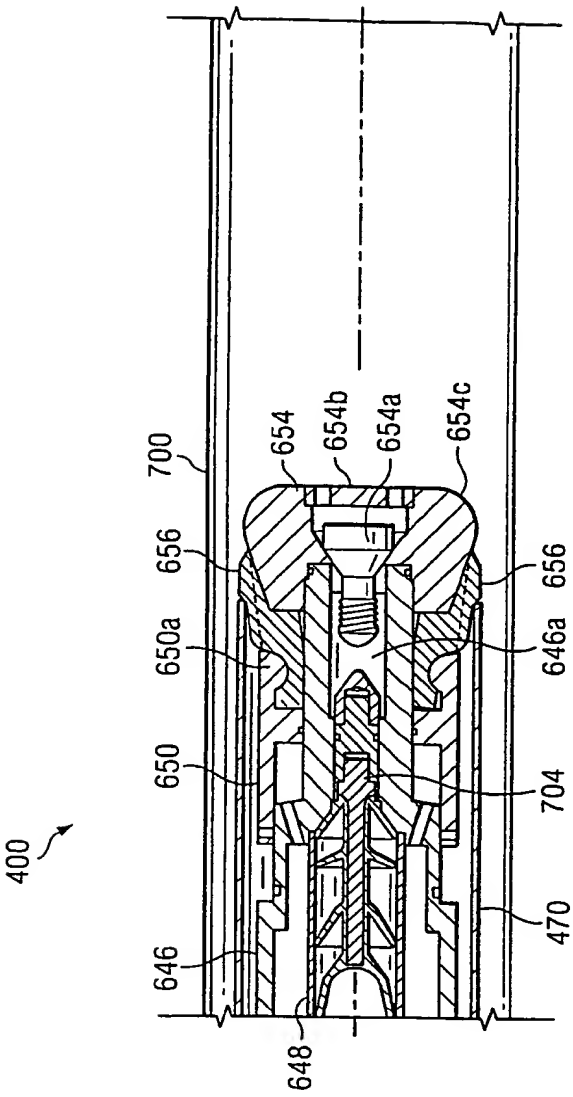

400
700
654
654b
654a
654c
656
656
650a
646a
650
704
470
646
648

Fig. 31n

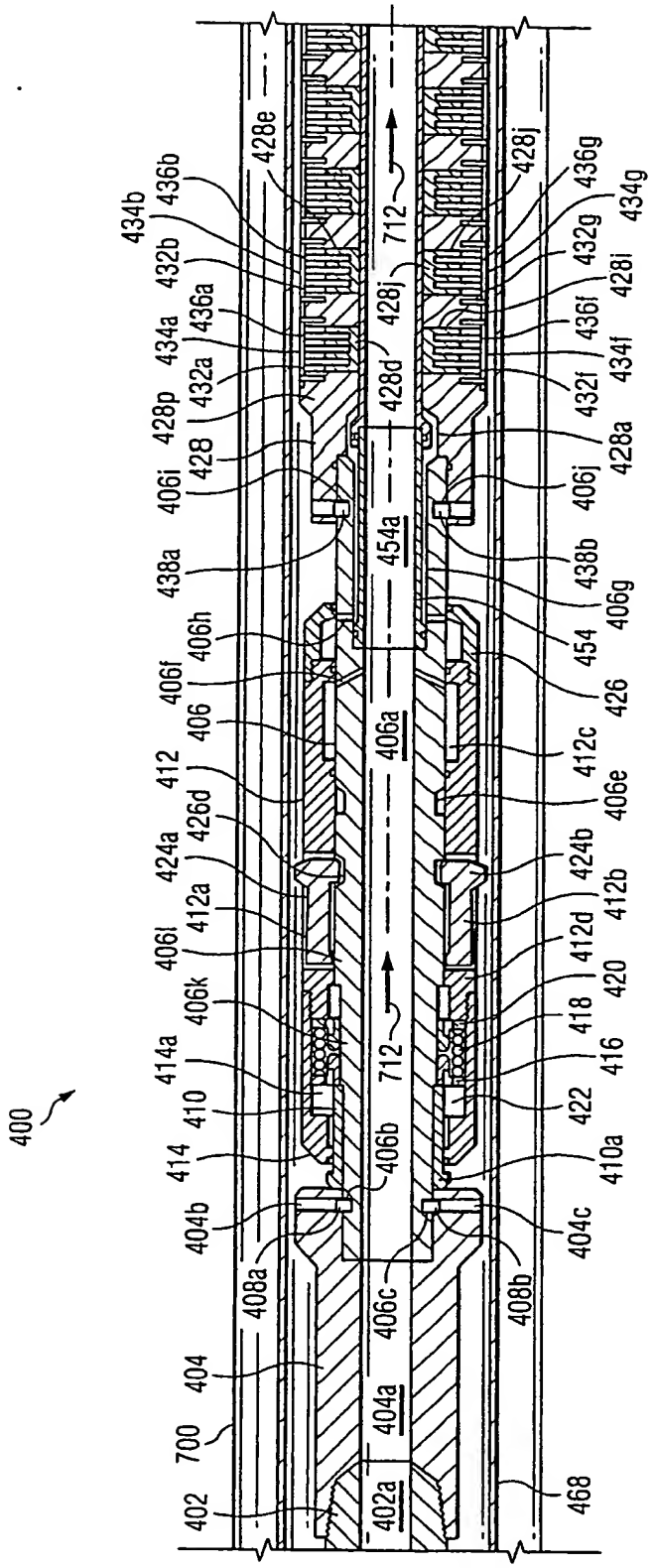

400
402
700
404
404a
402a
468
408a
408b
406c
406b
712
414
414a
410
404b
404c
410a
406b
712
406k
406l
412a
420
418
416
422
412d
412b
424b
406e
412c
426
454
406g
438b
406j
428a
406a
406h
406f
406
412
426d
424a
406i
428
428p
406i
438a
454a
428d
428j
712
428e
428j
436b
434b
432b
436a
434a
432a
436g
434g
432g
428i
436f
434f
432f

Fig. 32a

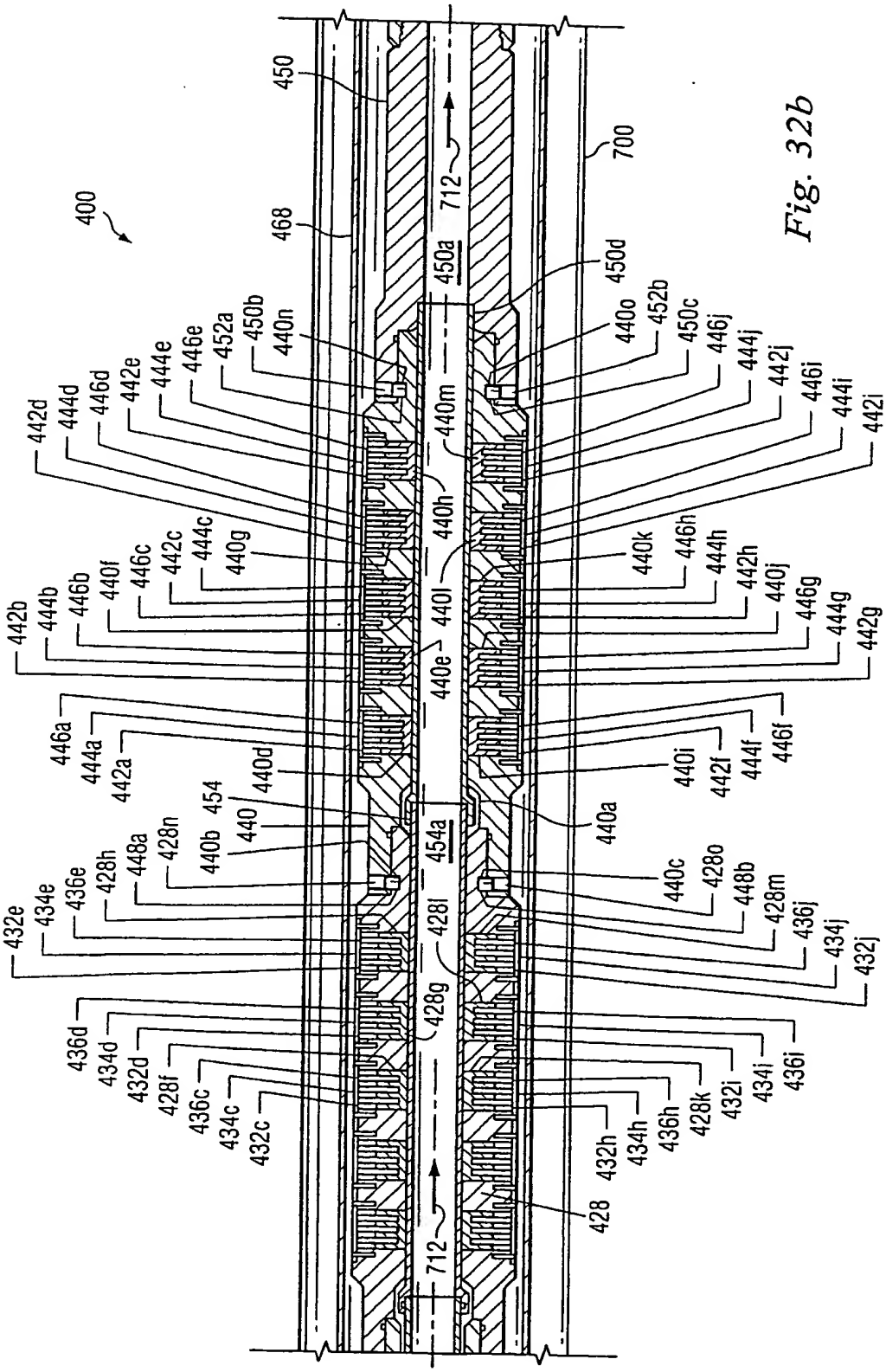

400
450
468
712
700
450a
450d
440o
452b
450c
446j
444j
442j
446i
444i
442i
442d
444d
446d
442e
444e
446e
452a
450b
440n
440m
440h
440k
446h
444h
442h
440j
446g
444g
442g
442b
444b
446b
440f
446c
442c
444c
440g
440l
440e
446a
444a
442a
440d
454
440
428n
440b
448a
428h
436e
434e
432e
454a
440a
440i
442f
444f
446f
440c
428o
448b
428m
436j
434j
432j
428l
428g
436d
434d
432d
428f
436c
434c
432c
428
432h
434h
436h
428k
432i
434i
436i
712

Fig. 32b

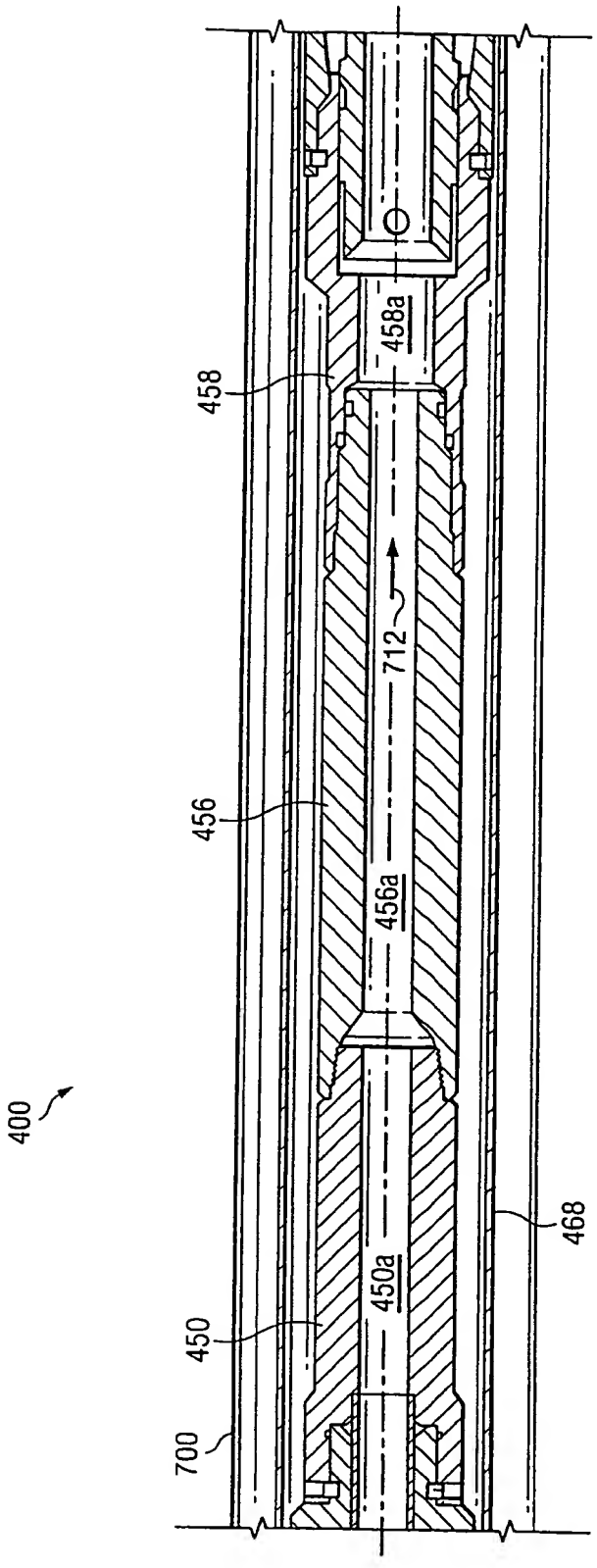


Fig. 32c

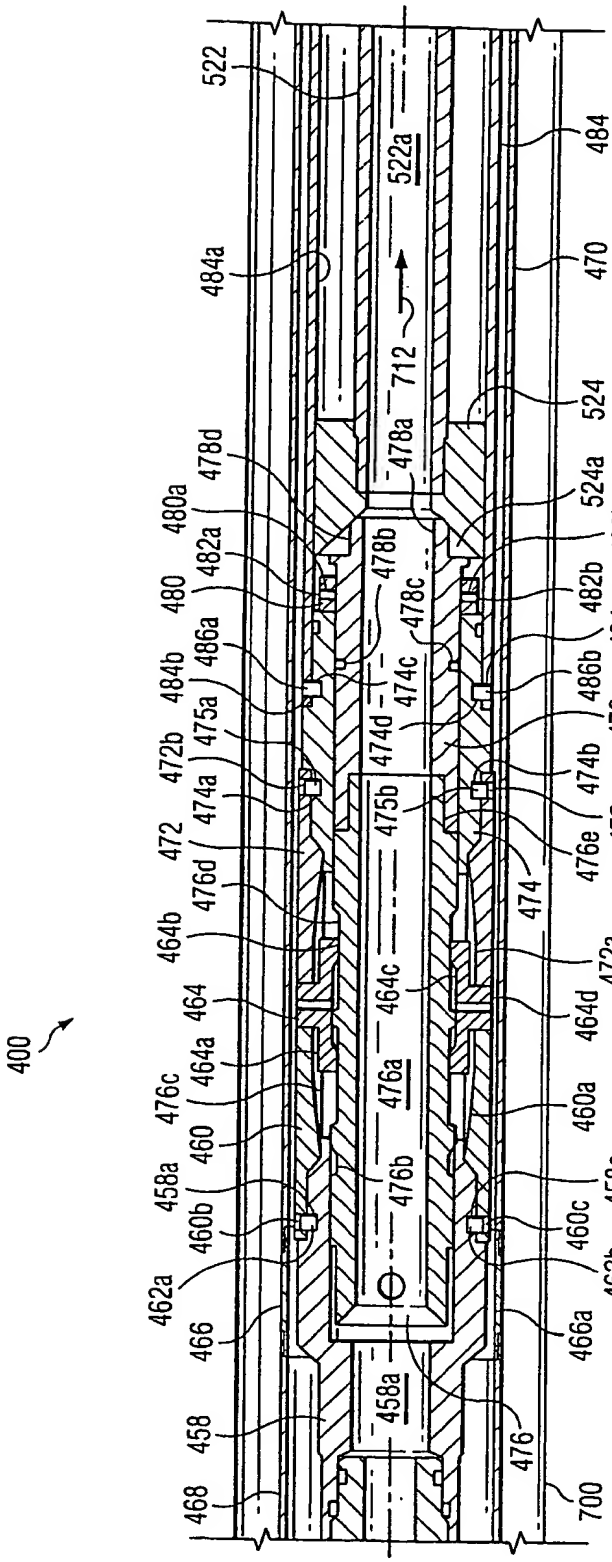

400
522
484
522a
484a
470
712
524
478a
478d
480a
524a
480b
482a
478b
480
482b
478c
484c
484b
486a
474c
486b
472b
475a
474d
478
474b
472
474a
475b
472c
476e
476d
474
464b
472a
464c
464d
464
464a
476c
476a
460a
460
458a
476b
458c
460b
460c
462a
462b
466
466a
458a
458
476
468
700

FIG. 32d

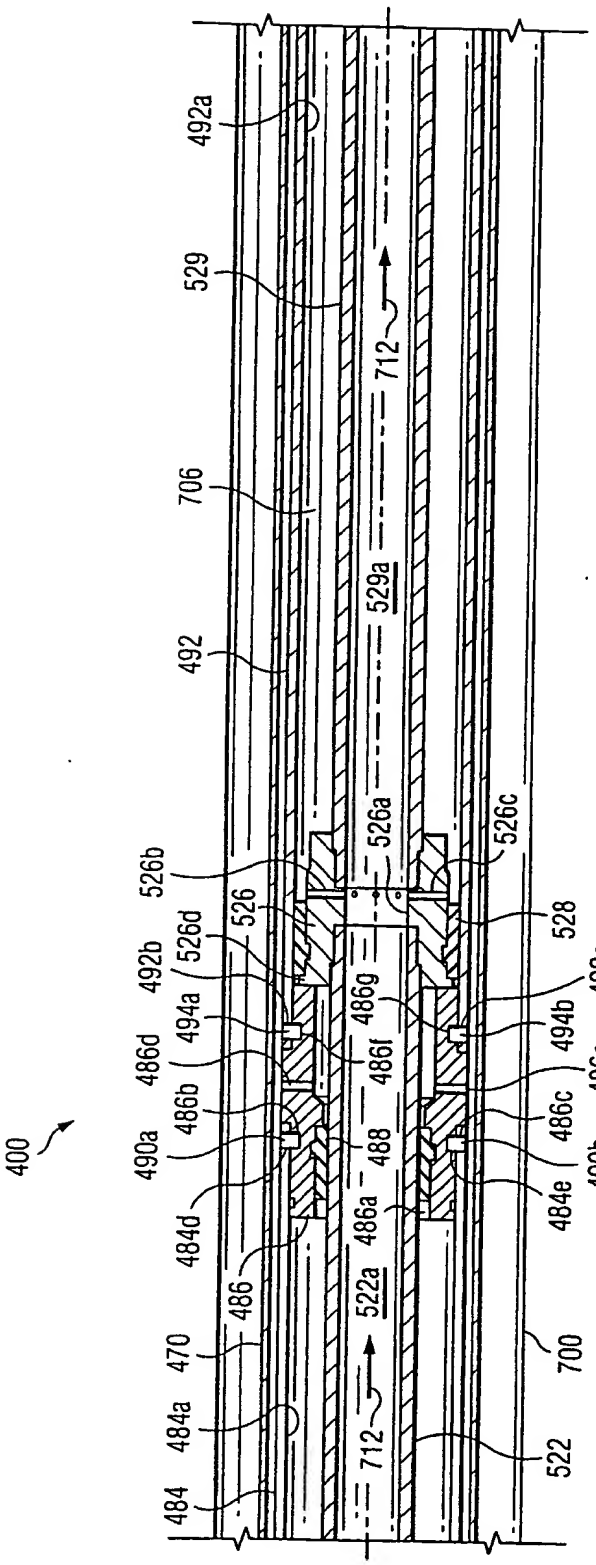

400
492a
529
712
706
492
529a
526a
526c
526b
526
526d
528
492b
494a
486g
492c
486d
486f
494b
486b
486e
490a
488
486c
490b
484d
486a
484e
486
522a
470
700
712
484a
522
484

Fig. 32e

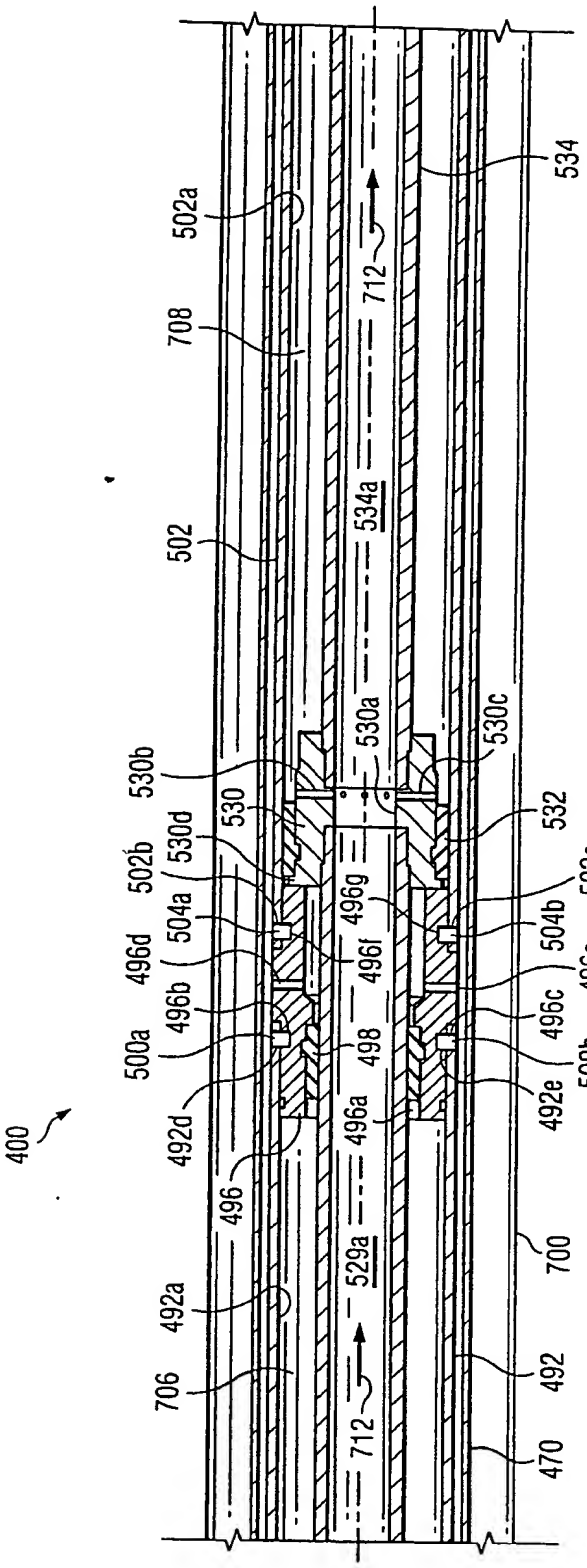

400
492a
706
492d
496
529a
712
496a
498
500a
496b
496d
504a
502b
530d
530
530b
502
708
502a
534a
530a
530c
534
712
532
502c
504b
496e
496c
500b
492e
492
700
470
496g
496f

Fig. 32f

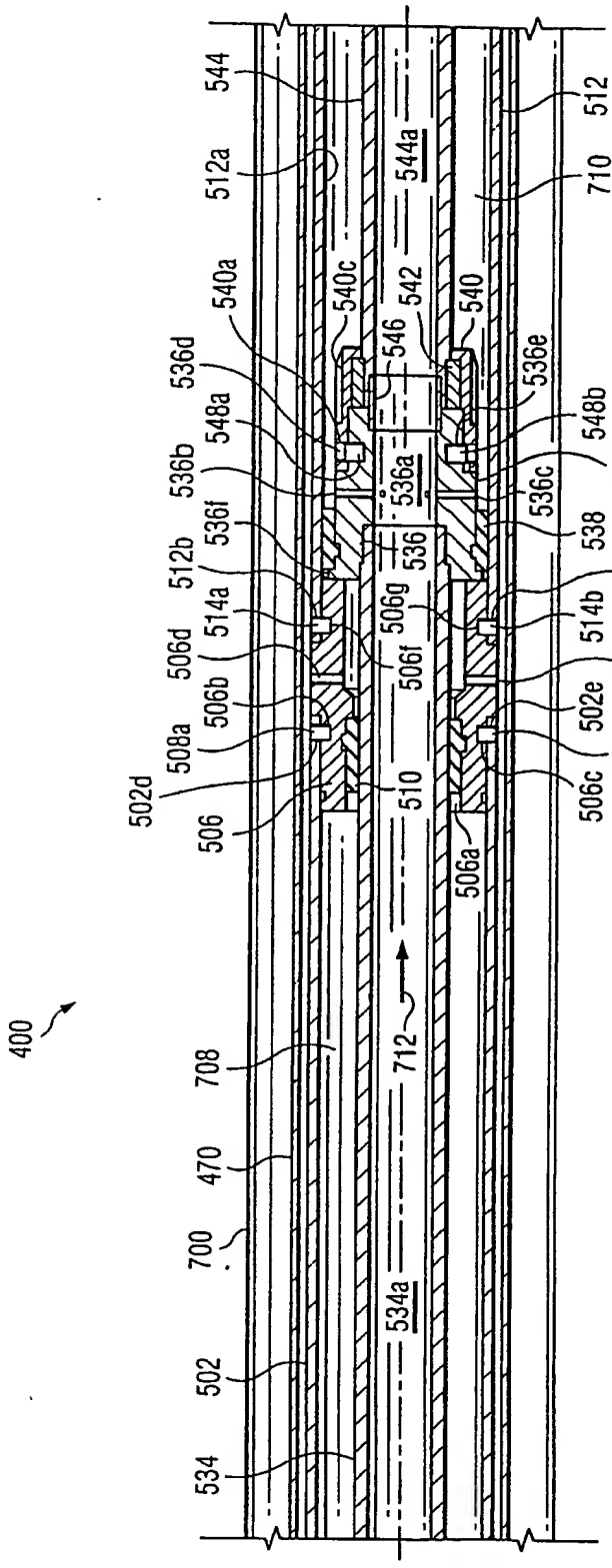

400
534
502
700
470
708
712
534a
502d
506
508a
506d
506b
514a
512b
536l
536b
548a
536d
540a
544
512a
544a
512
710
540c
542
546
540
536e
548b
540b
536c
538
512c
514b
506e
502e
508b
506c
506a
510
506f
506g
536
536a

Fig. 32g

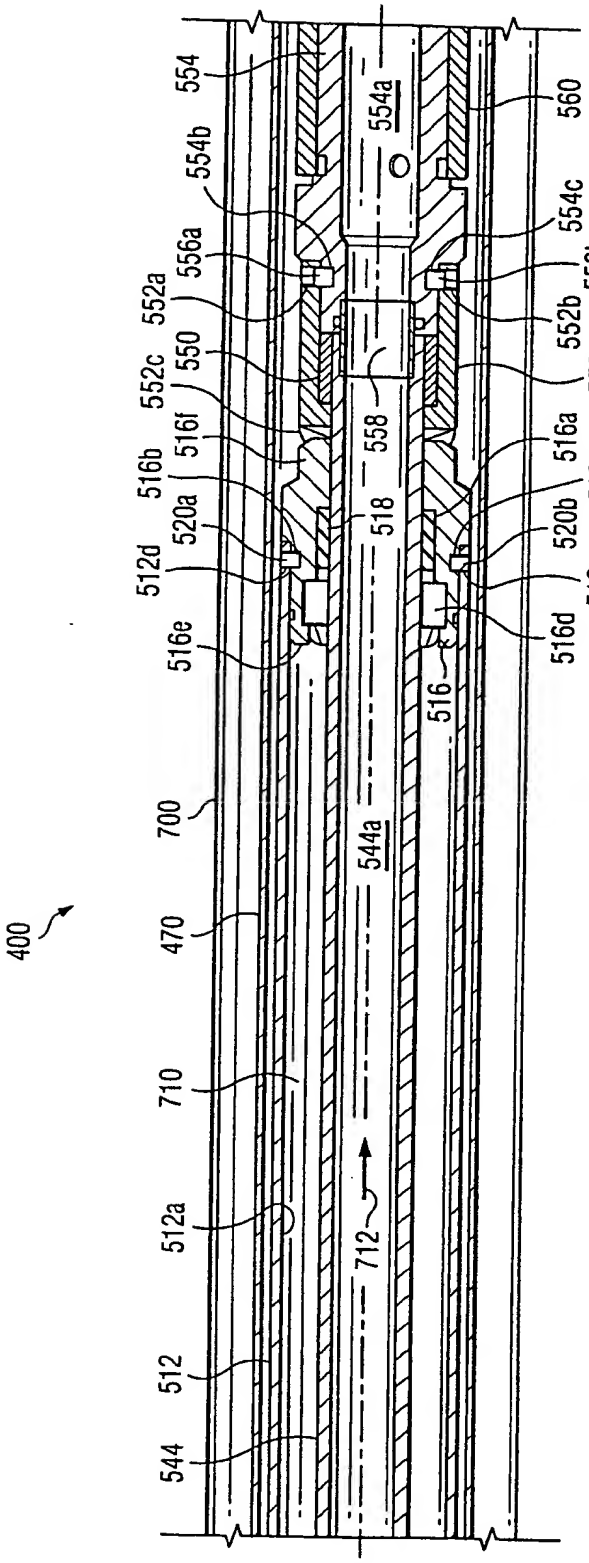

400
544
512
512a
710
470
700
544a
712
512d
516e
516b
520a
516f
552c
550
552a
556a
554b
554
554a
560
554c
556b
552b
552
516a
516c
520b
512e
516d
516
518
558

Fig. 32h

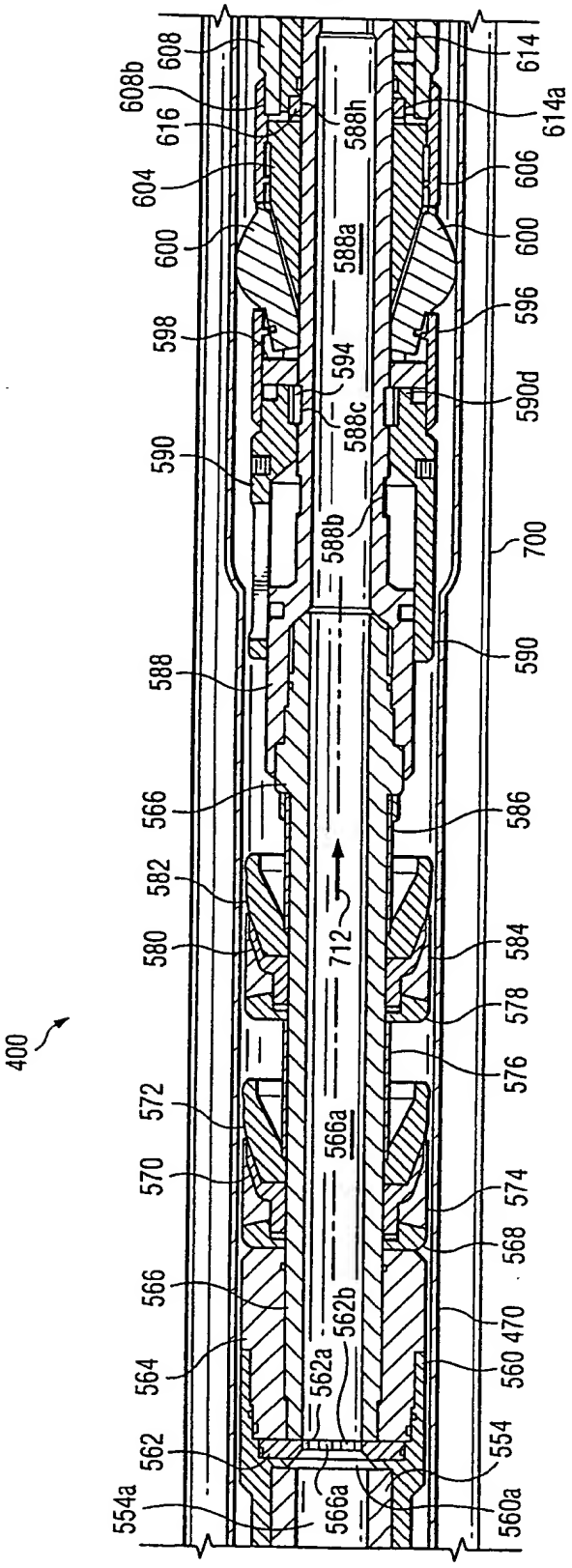

400
608b
608
616
604
600
598
590
588
566
582
580
572
570
566
564
562
554a
614
614a
606
600
596
590d
700
590
586
584
578
576
574
568
470
560
554
560a
588h
588a
594
588c
588b
712
566a
562b
562a
566a

Fig. 32i

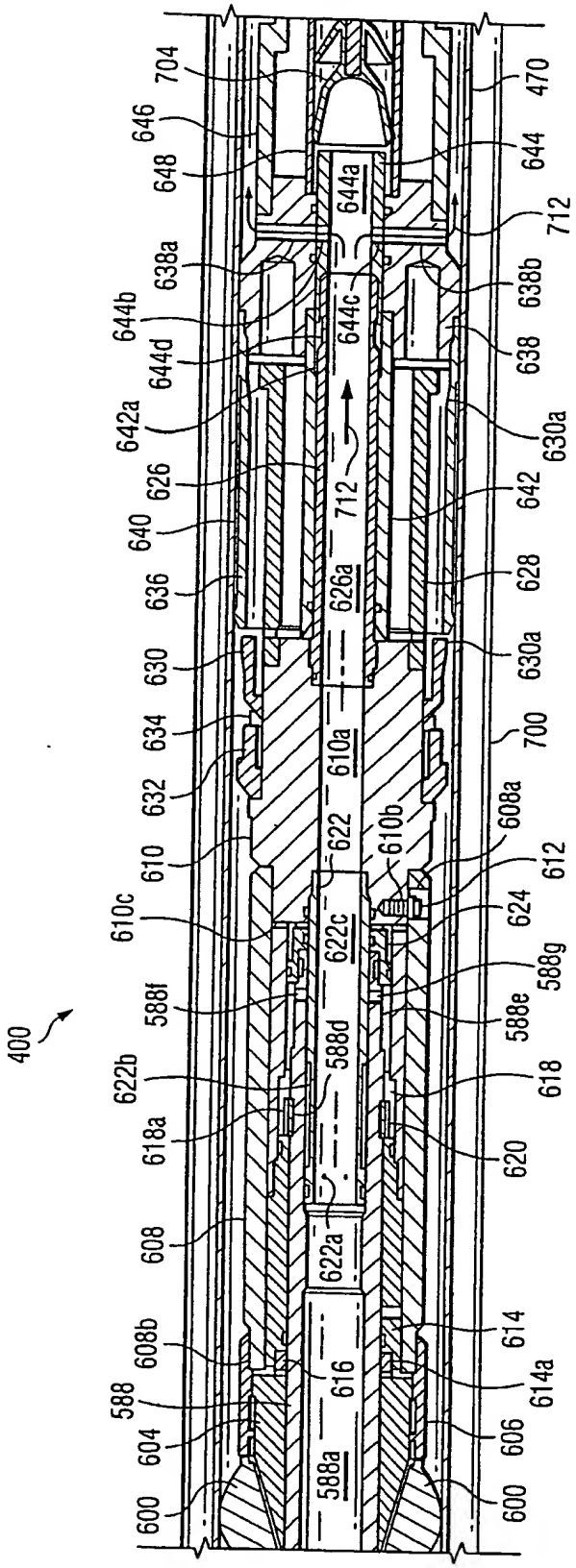

400
704
646
648
644a
644
470
712
638a
638b
644b
644c
644d
638
642a
630a
626
712
642
640
628
636
626a
630
630a
634
610a
700
632
608a
610
622
610b
612
610c
624
622c
588g
588f
588e
588d
622b
618
618a
620
608
622a
614
608b
616
614a
588
604
606
588a
600
600

Fig. 32j

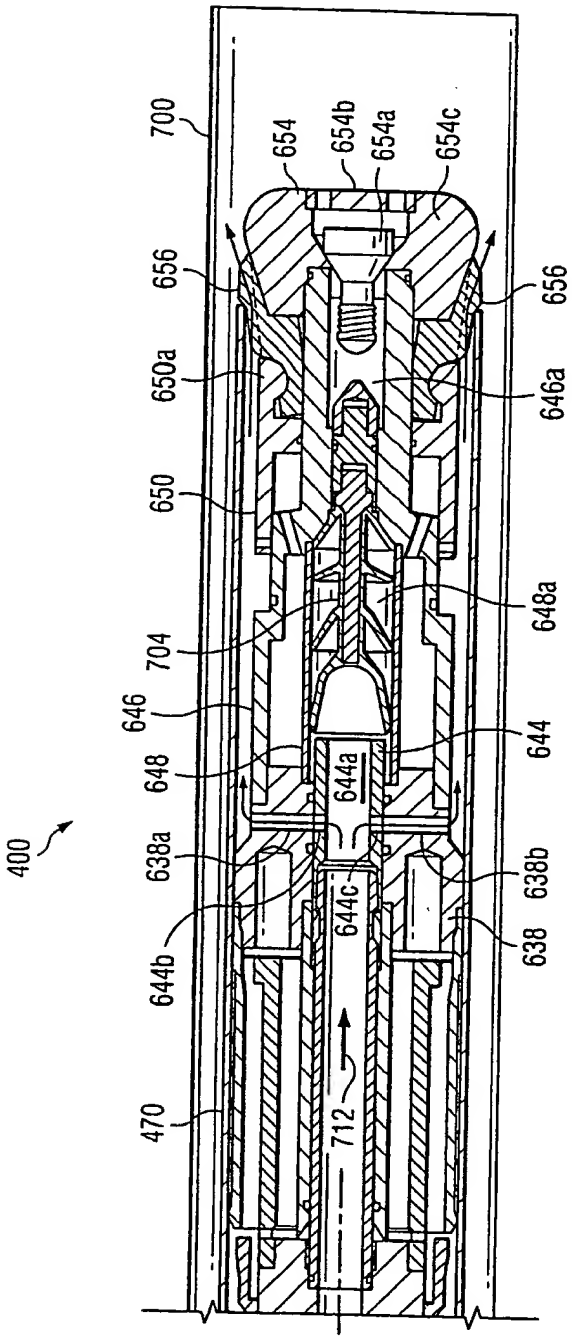

400
700
654
654b
654a
654c
656
656
650a
646a
650
704
648a
646
644
648
644a
638a
638b
644c
644b
638
470
712

Fig. 32k

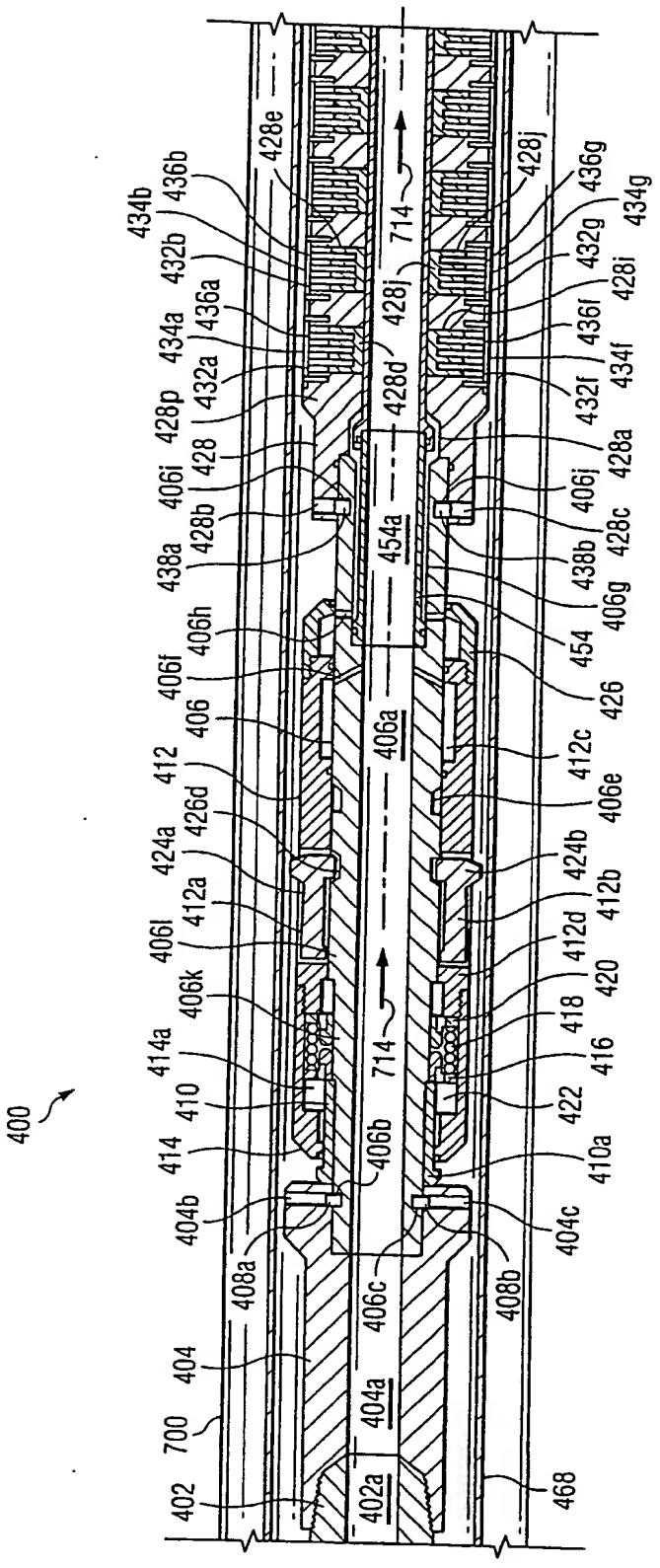

400
402
700
404
404a
402a
404b
408a
414
410
414a
406k
406l
412a
424a
426d
412
406
406f
406h
438a
428b
428
406i
428p
432a
434a
436a
432b
434b
436b
428e
406b
406c
714
406a
454a
428d
428j
714
428j
436g
434g
432g
428i
436f
434f
432f
428a
406j
428c
438b
406g
454
426
412c
406e
424b
412b
412d
420
418
416
422
410a
404c
408b
468

Fig. 33a

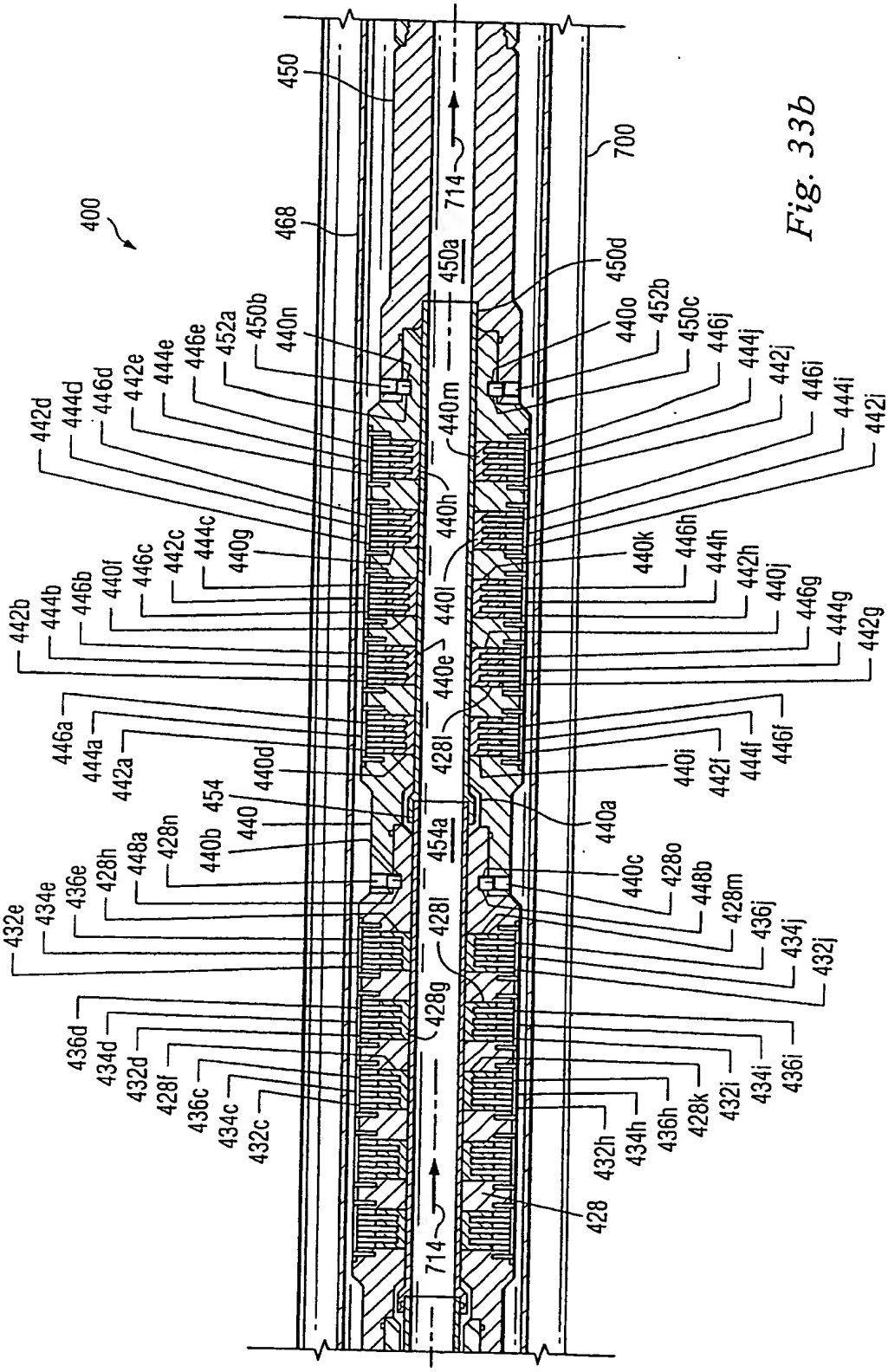

400
450
468
714
700
450a
450d
452b
450c
446j
444j
442j
446i
444i
442i
440o
440m
440h
440k
446h
444h
442h
440j
446g
444g
442g
440l
440e
428l
440i
442f
444f
446f
440a
440c
428o
448b
428m
436j
434j
432j
428g
428
432h
434h
436h
428k
432i
434i
436i
714
454a
454
440
440b
440d
448a
428n
428h
436e
434e
432e
446a
444a
442a
442d
444d
446d
442e
444e
446e
452a
450b
440n
442b
444b
446b
440f
446c
442c
444c
440g

Fig. 33b

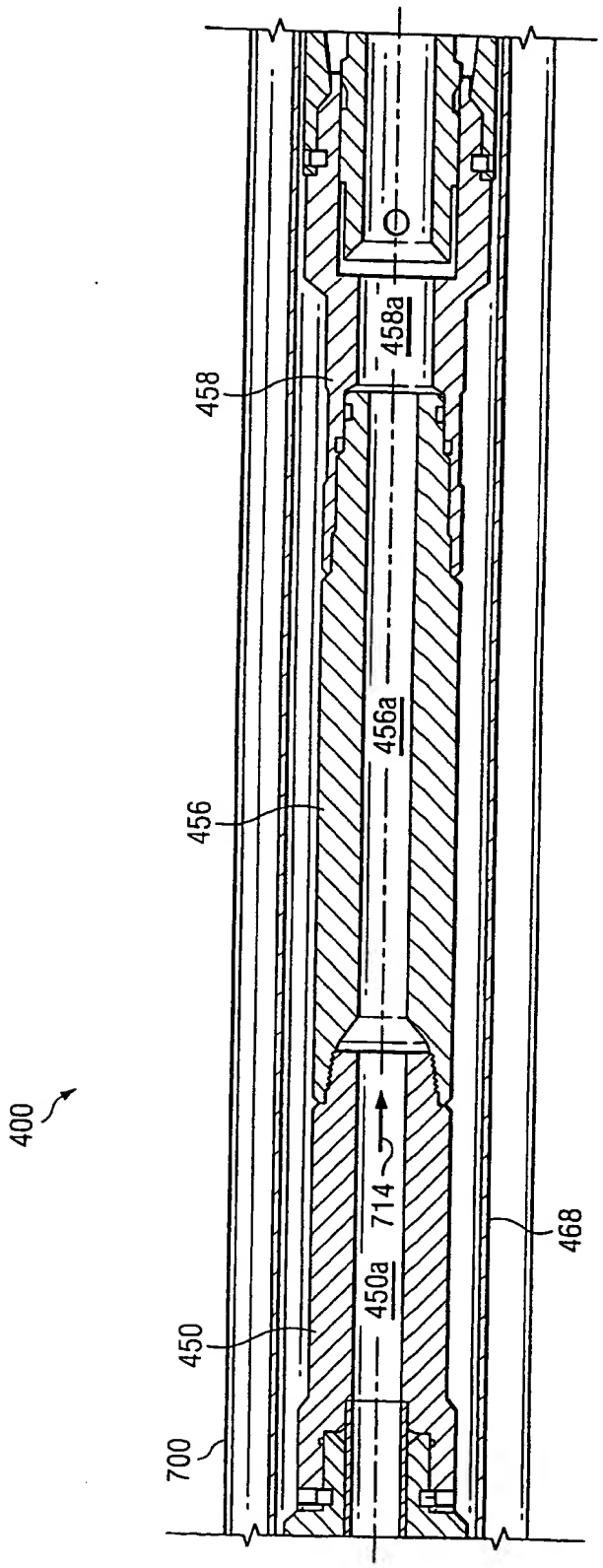


Fig. 33c

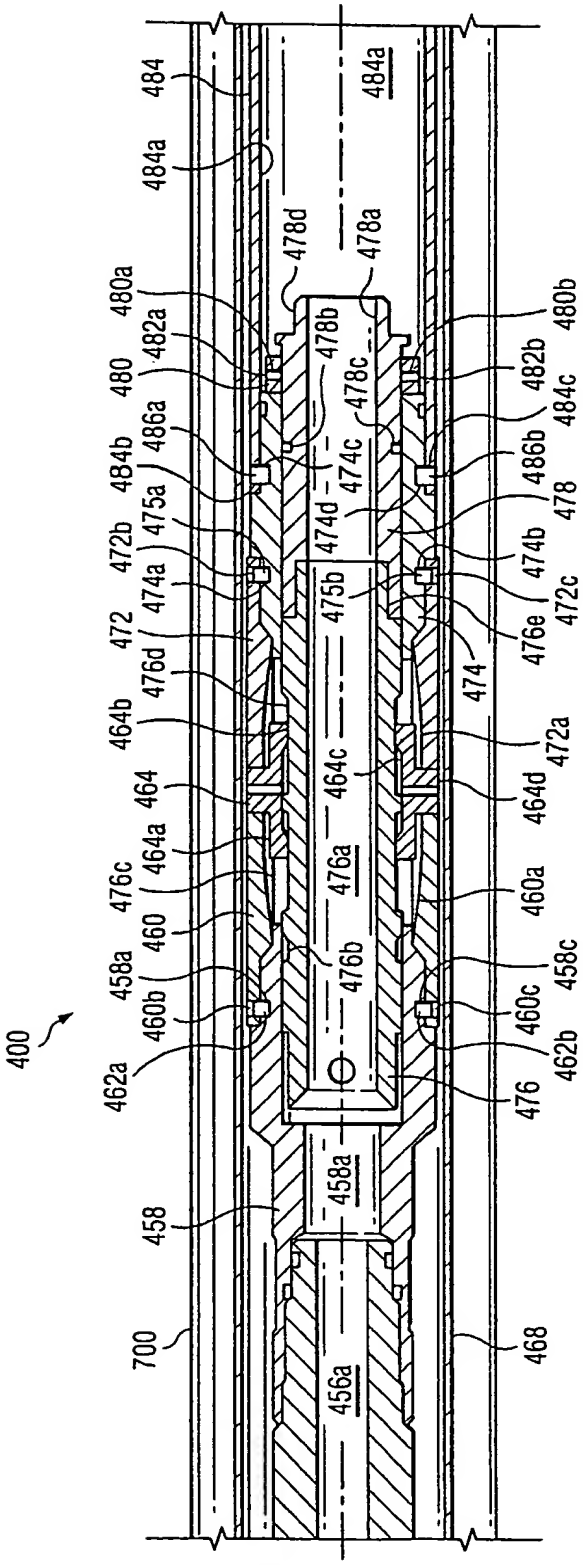

400
700
458
458a
456a
462a
460b
460
458a
464a
464
464b
464c
464d
476c
476a
476b
476d
476e
476
474
474a
474b
474c
474d
472
472a
472b
472c
475a
475b
478
478a
478b
478c
478d
480
480a
480b
482a
482b
484
484a
484b
484c
486a
486b
460a
460c
458c
462b
468

Fig. 33d

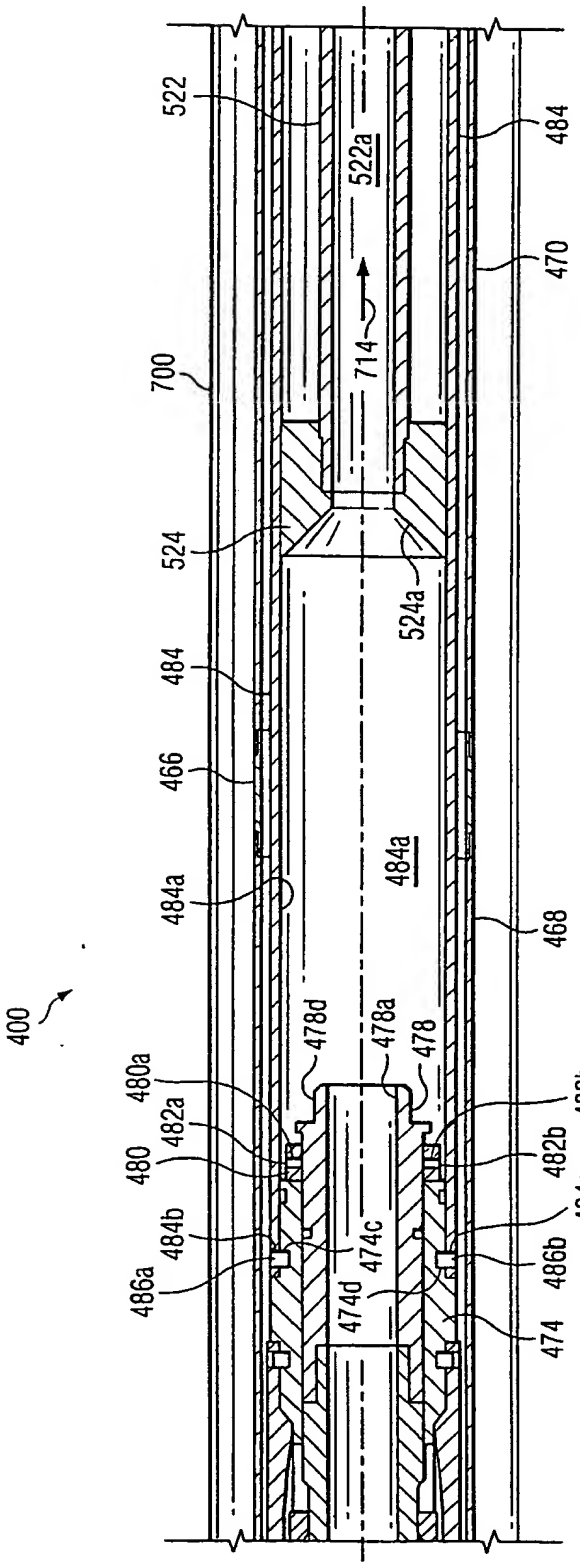

400
522
522a
484
470
700
714
524
524a
484
466
484a
484a
468
478d
478a
478
480a
480b
482a
480
482b
484c
484b
474c
486b
486a
474d
474

Fig. 33e

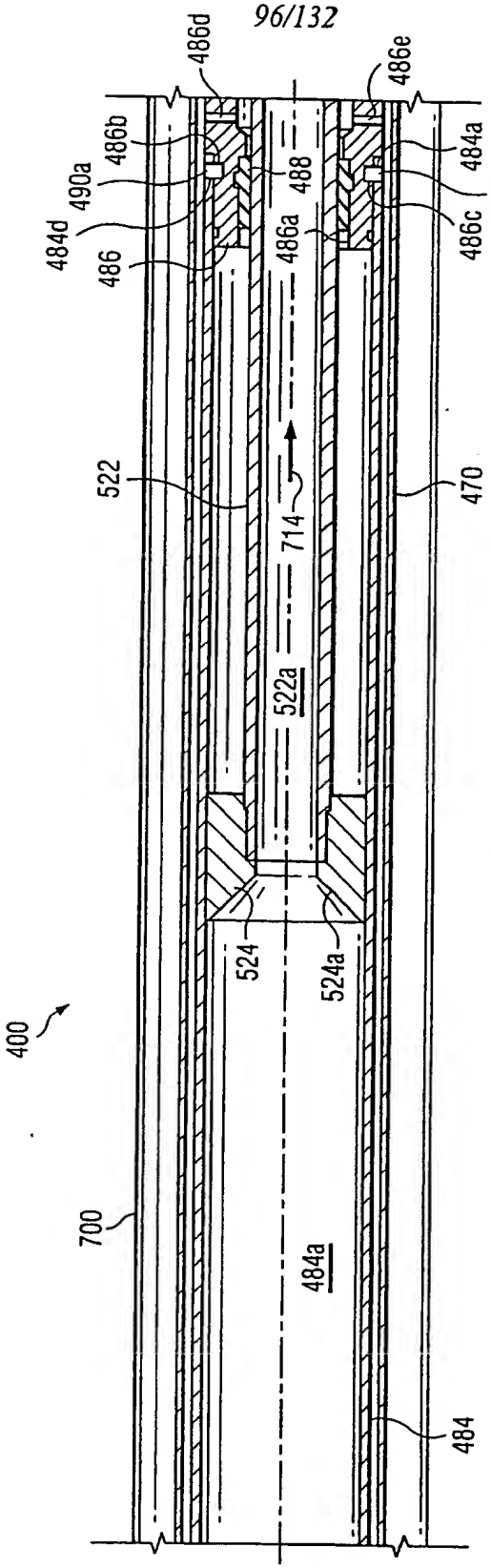

486d
486e
486b
484a
490a
488
490b
484d
486a
486c
486
522
714
470
522a
524
524a
400
700
484a
484

Fig. 33f

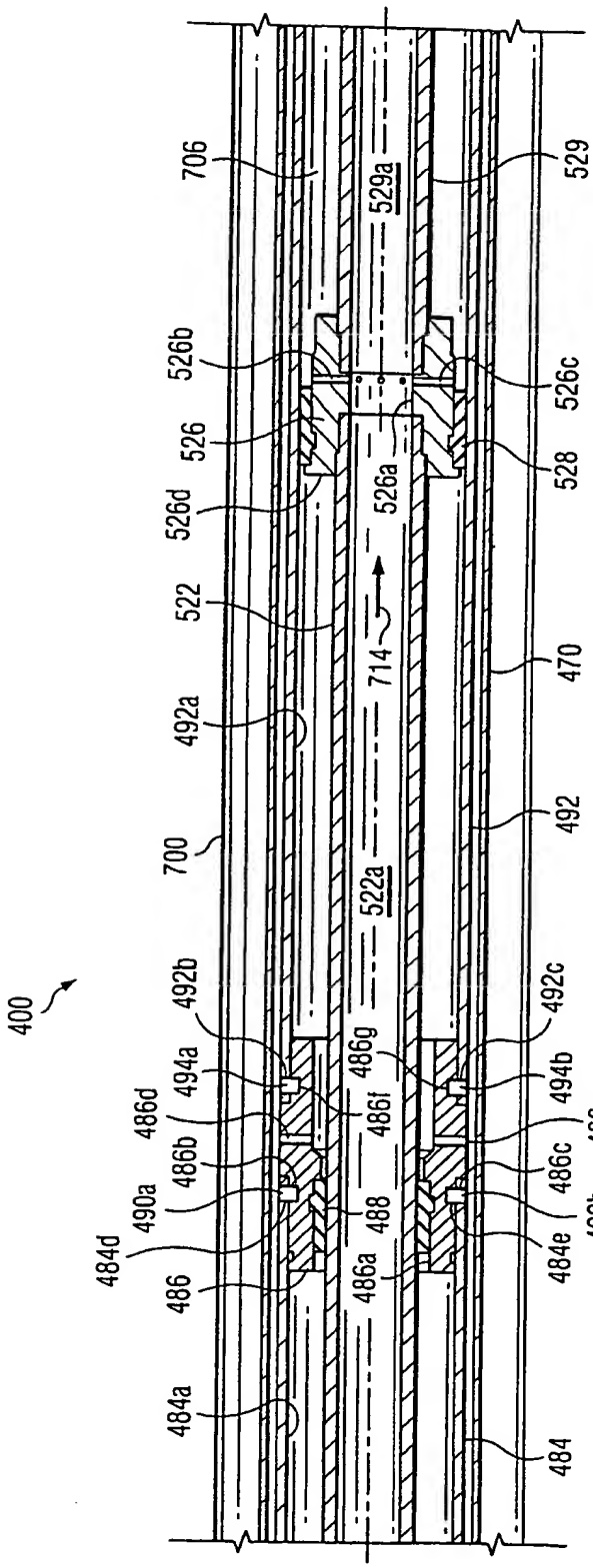

400
706
529a
529
526b
526c
526
528
526a
526d
522
714
470
492a
492
700
522a
492b
492c
494a
494b
486g
486f
486d
486e
486b
486c
490a
490b
488
484d
484e
486
486a
484a
484

Fig. 33g

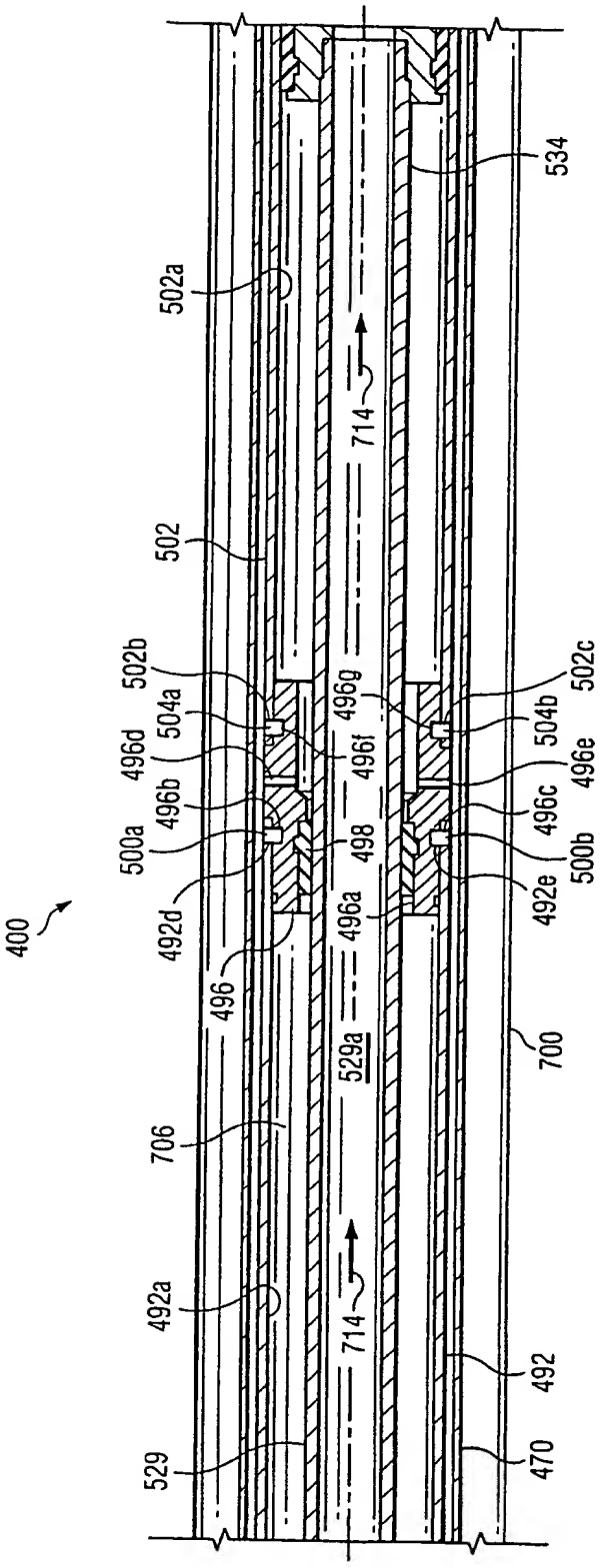

400
492d
496
492a
529
706
529a
714
714
492
470
700
534
502a
502
502b
504a
496d
496b
500a
498
496a
496g
496f
502c
504b
496e
496c
500b
492e

Fig. 33h

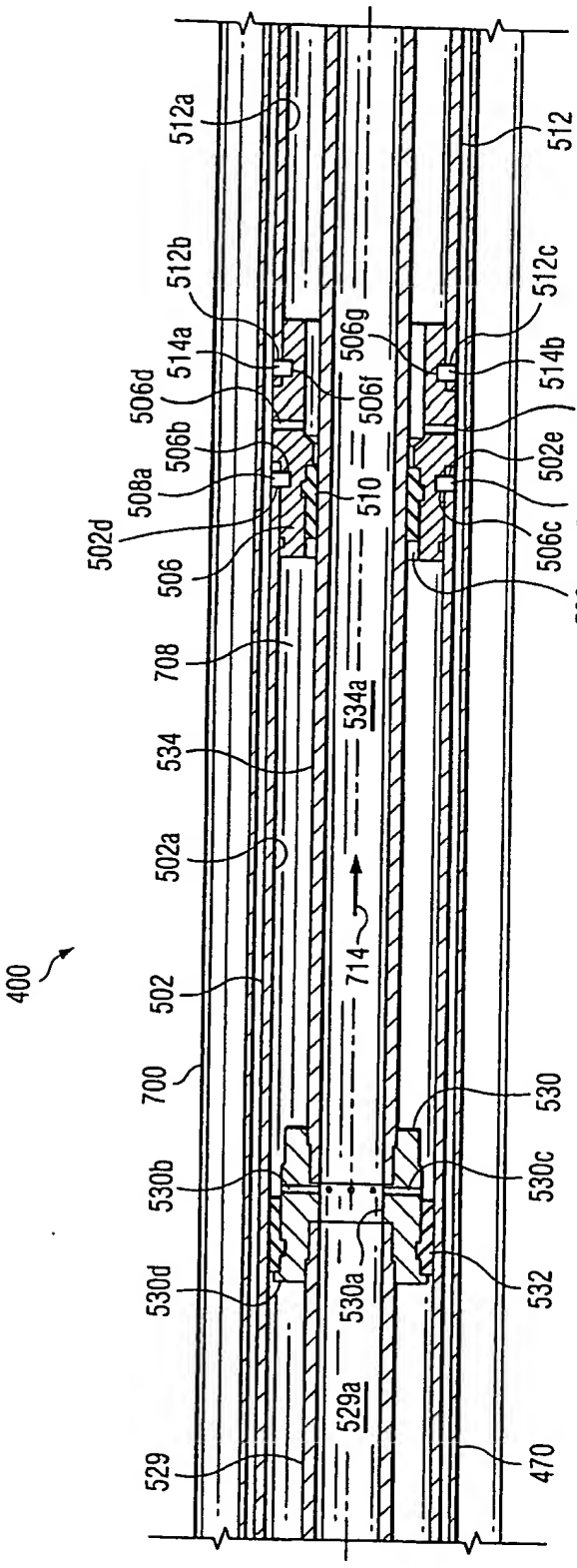

400
502d
502
502a
534
708
506
508a
506b
506d
514a
512b
512a
506g
506f
510
534a
714
700
530b
530d
530a
529a
529
530
530c
532
470
512
512c
514b
506e
502e
508b
506c
506a

Fig. 33i

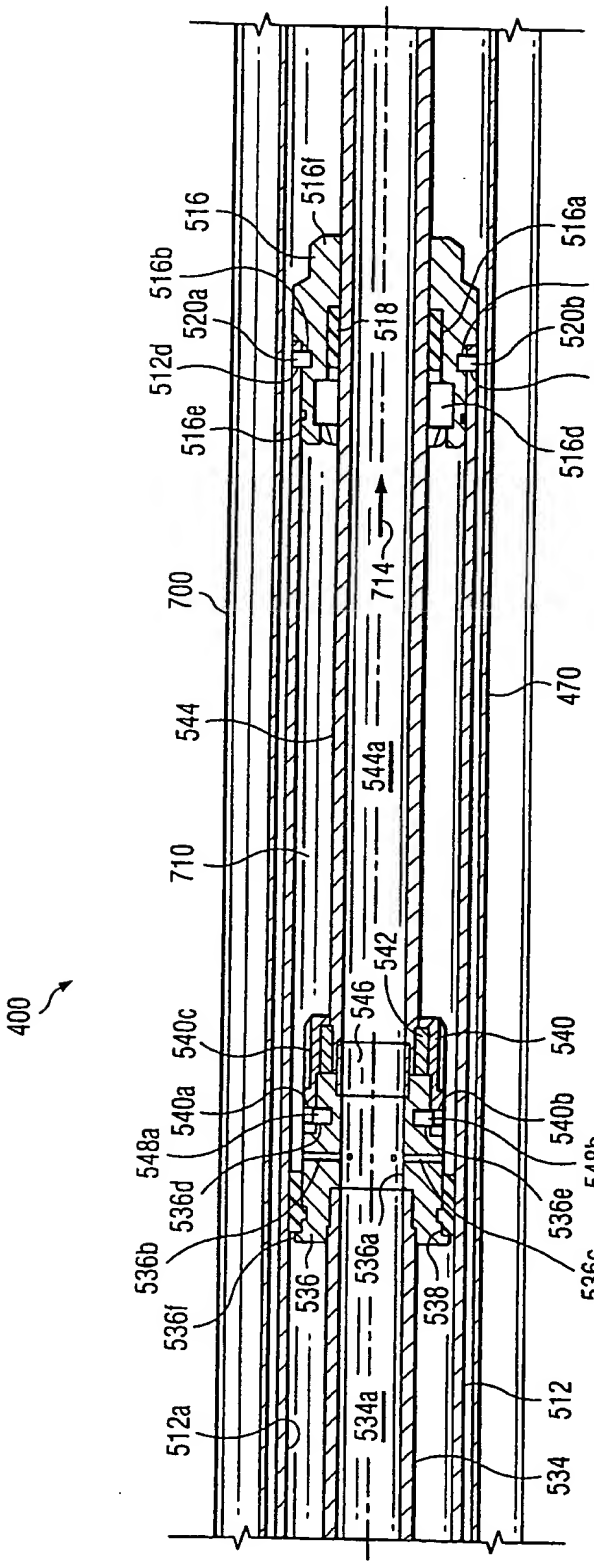

400
512a
534
534a
512
536f
536b
536
536a
538
536c
536e
548b
536d
548a
540a
540c
540b
540
546
542
544a
544
710
700
714
470
516f
516
516b
520a
512d
516e
518
516a
516c
520b
512e
516d

Fig. 33j

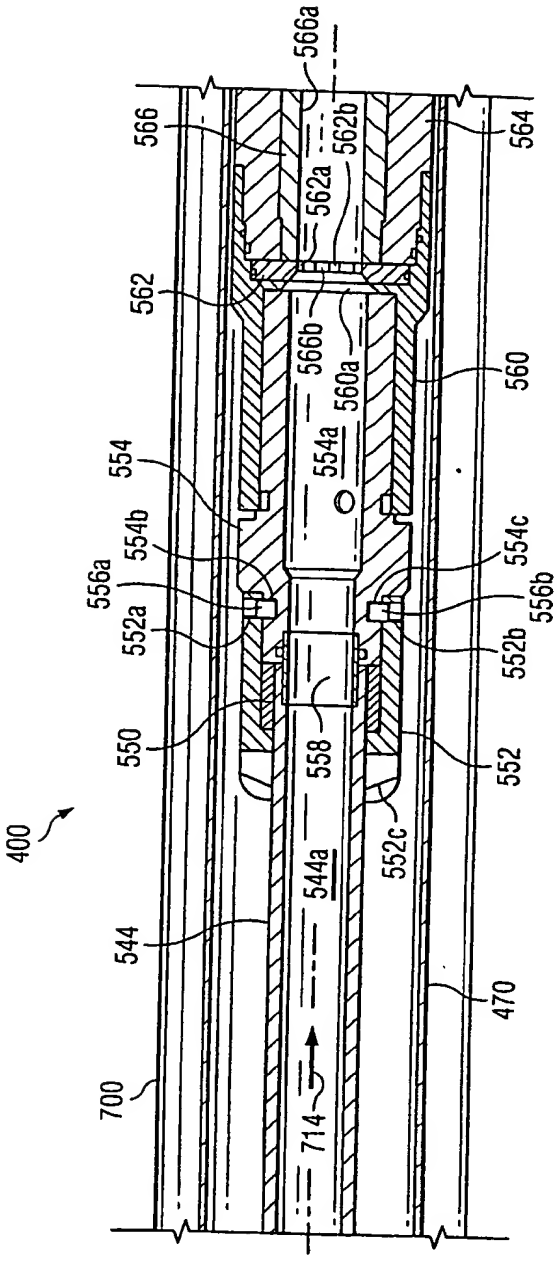

566a
566
562b
564
562a
562
566b
560a
560
554a
554
554b
554c
556a
556b
552a
552b
550
558
552
552c
544a
544
470
700
714
400

Fig. 33k

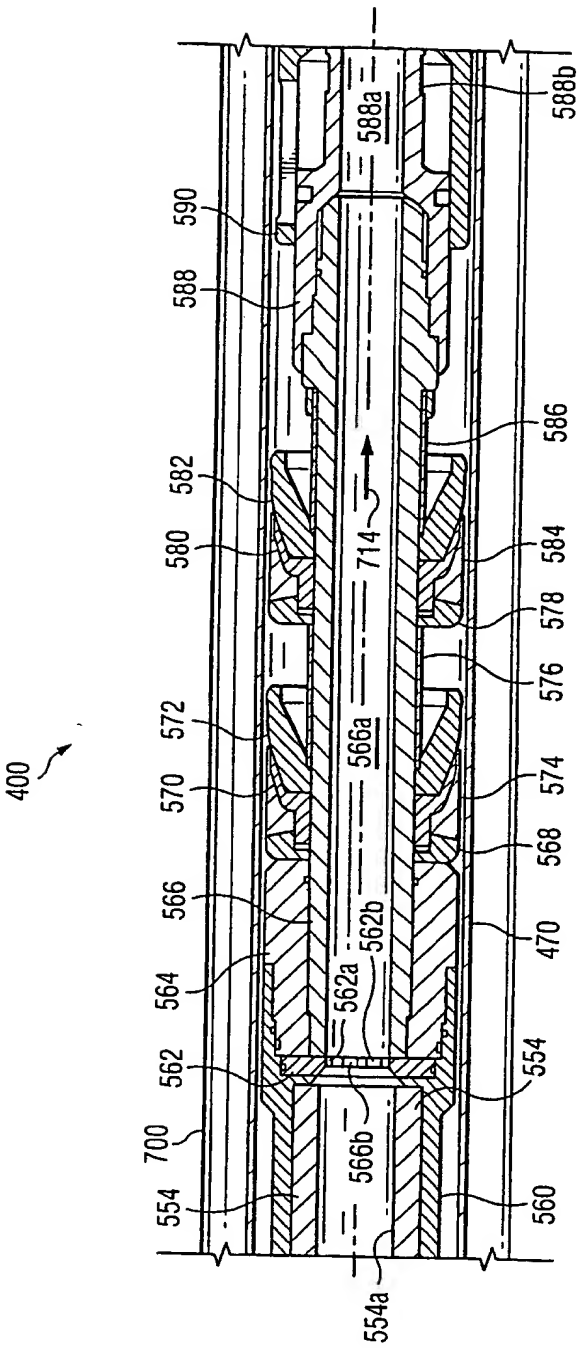

400
554
700
562
564
566
570
572
580
582
588
590
588a
588b
586
584
578
576
574
568
470
554
560
554a
566b
562a
562b
566a
714

Fig. 331

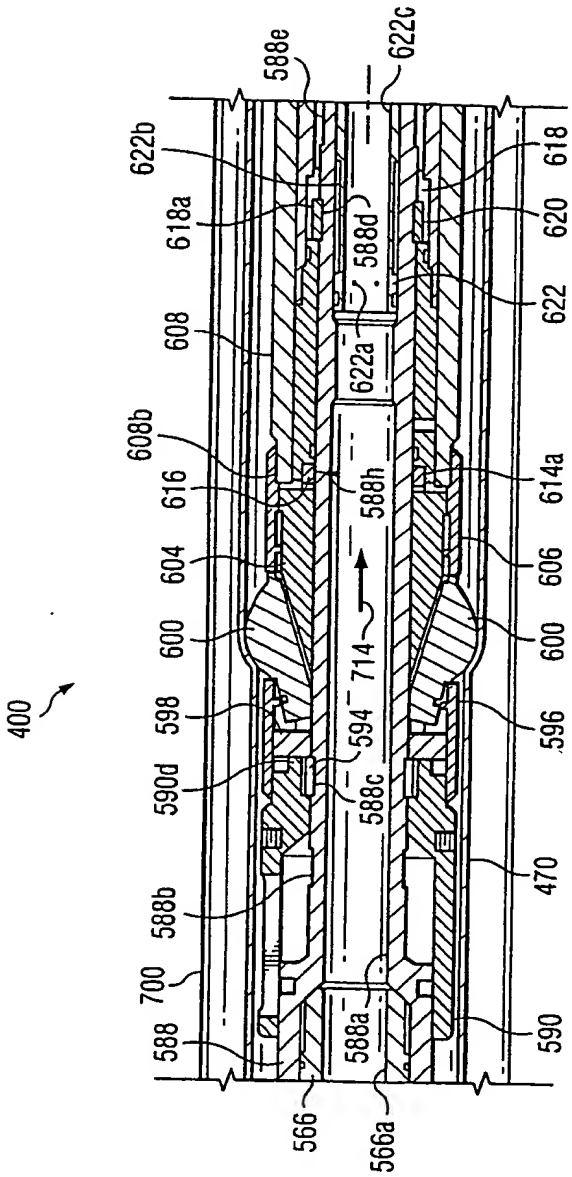

400
588e
622c
622b
618a
608
608b
616
604
600
598
590d
588b
700
588
566
566a
588a
590
588c
594
714
588h
622a
588d
618
620
622
614a
606
600
596
470

Fig. 33m

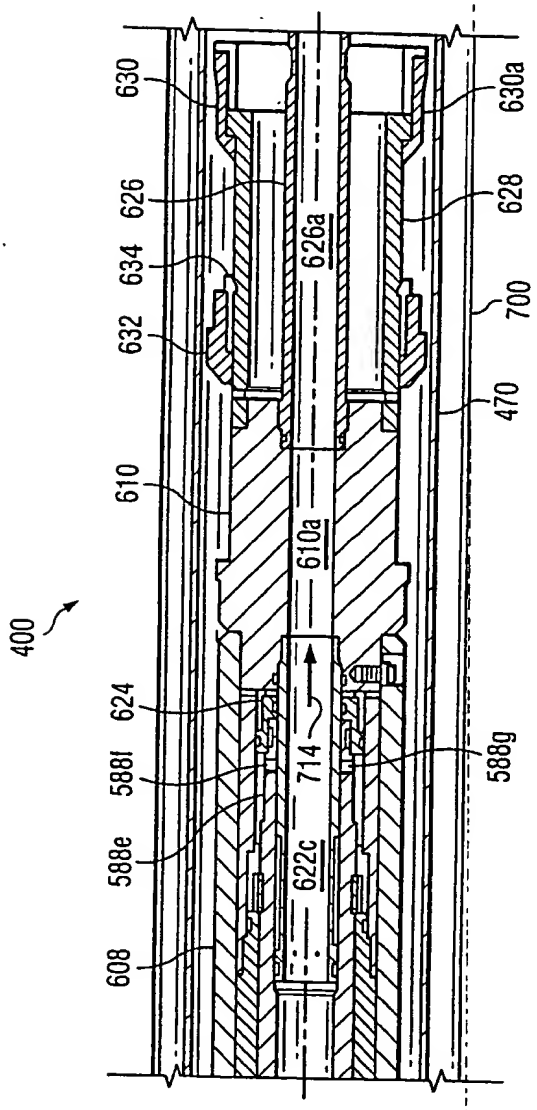

400
630
626
634
632
610
624
588l
588e
608
626a
610a
714
622c
630a
628
700
470
588g

Fig. 33n

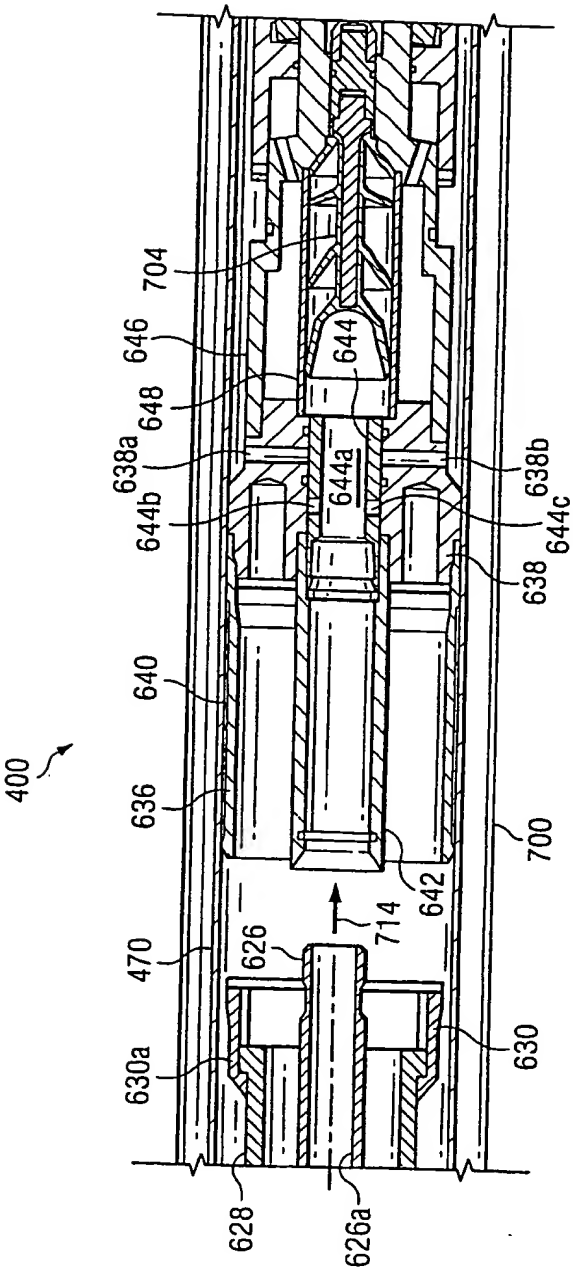

400
704
646
644
648
638a
644a
638b
644b
644c
638
640
636
700
642
714
626
470
630
630a
628
626a

Fig. 33o

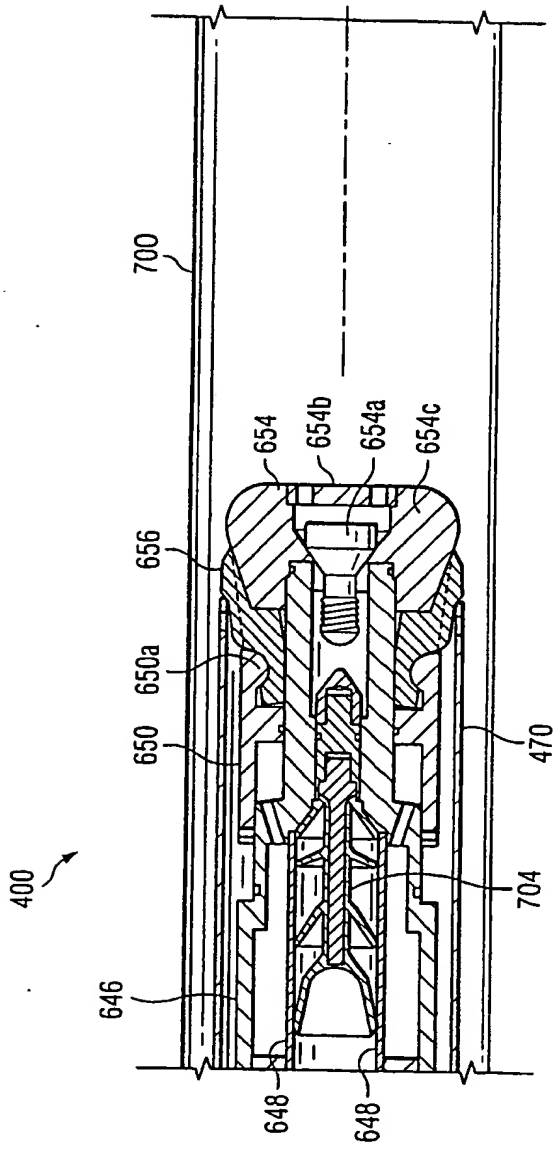
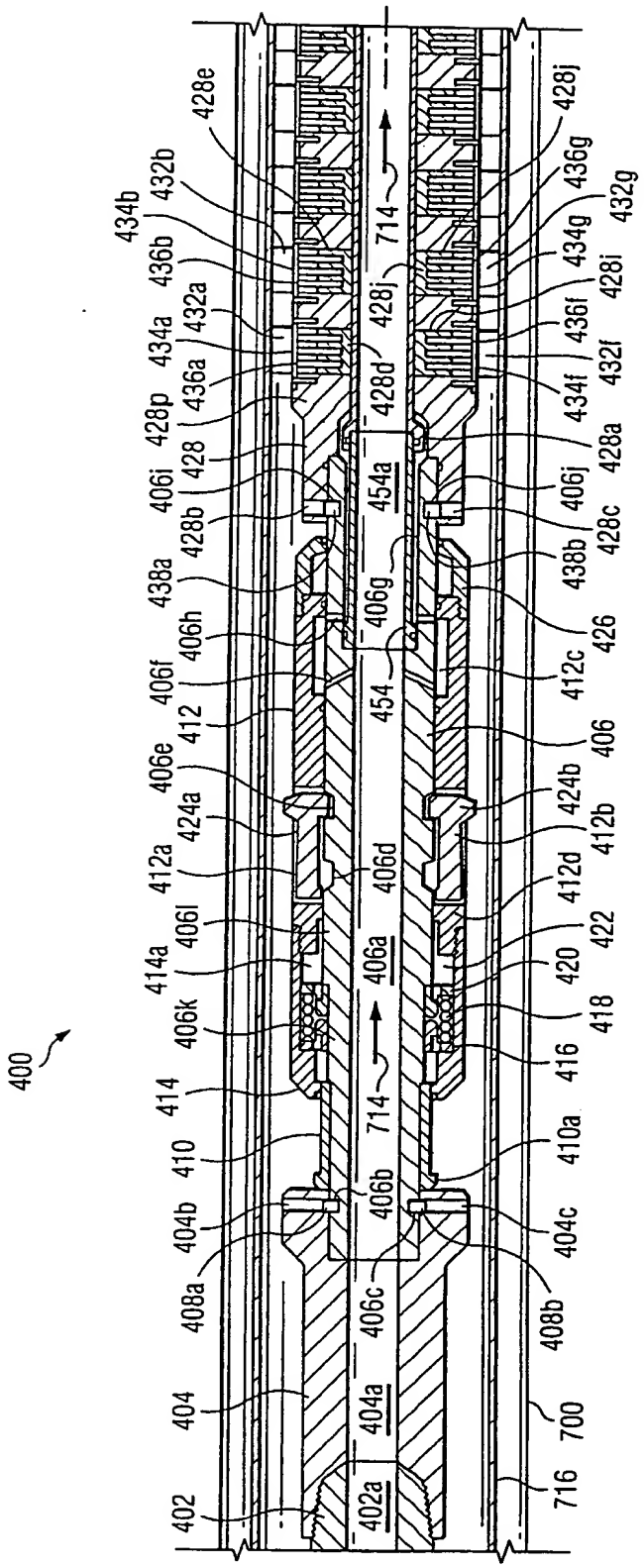


Fig. 33p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428g
428h
428i
428j
428p
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432f
432g
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434b
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434g
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436f
436g
438a
438b
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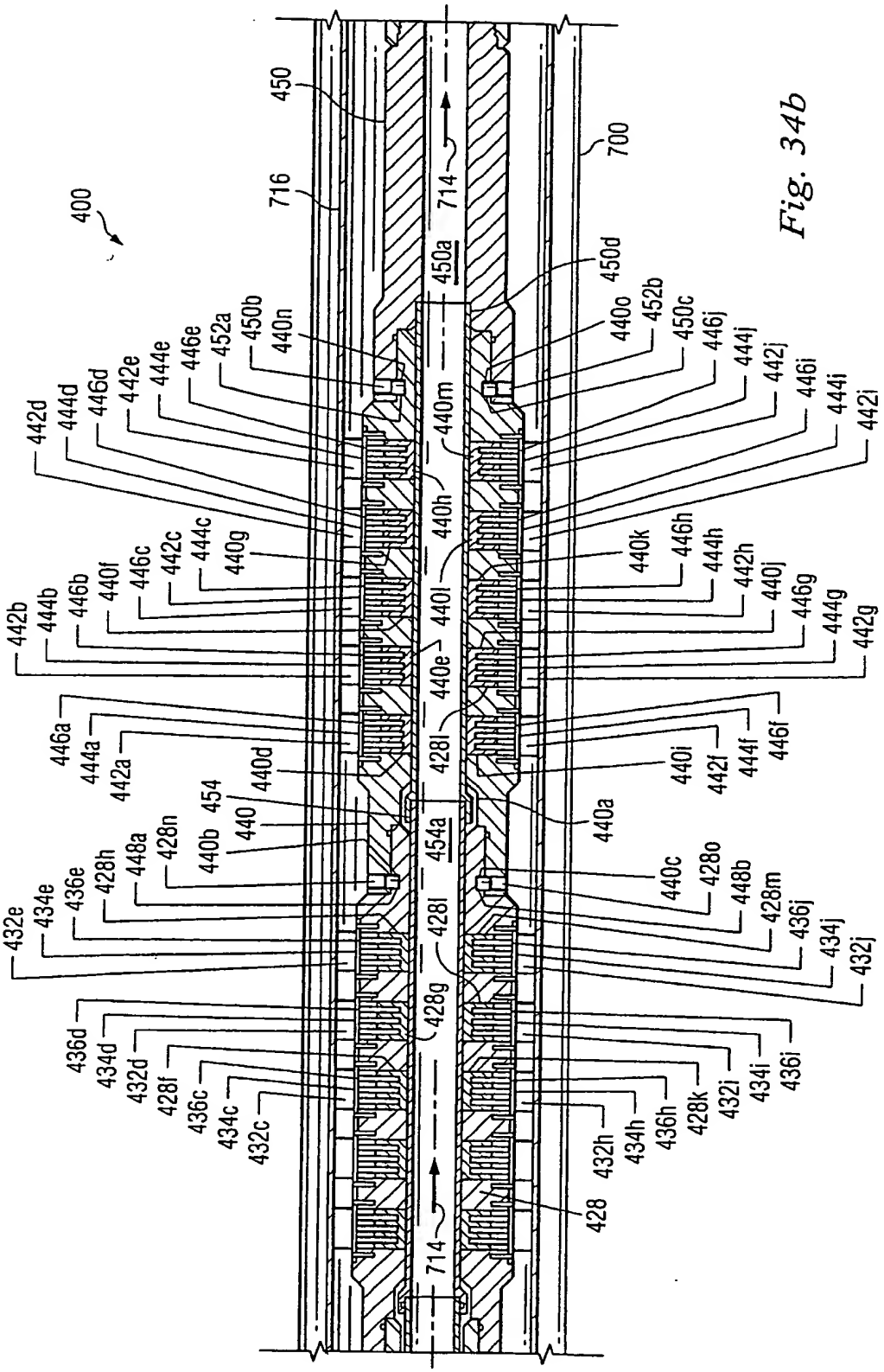
454a
700
714
716

Fig. 34a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440o
452b
450c
446j
444j
442j
446i
444i
442i
440m
440h
440l
440e
428l
440d
454
440
440b
428n
448a
428h
436e
434e
432e
454a
440a
440k
446h
444h
442h
440j
446g
444g
442g
440c
428o
448b
428m
436j
434j
432j
446a
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440i
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432d
428f
436c
434c
432c
428
432h
434h
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434i
436i
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446c
442c
444c
440g

Fig. 34b

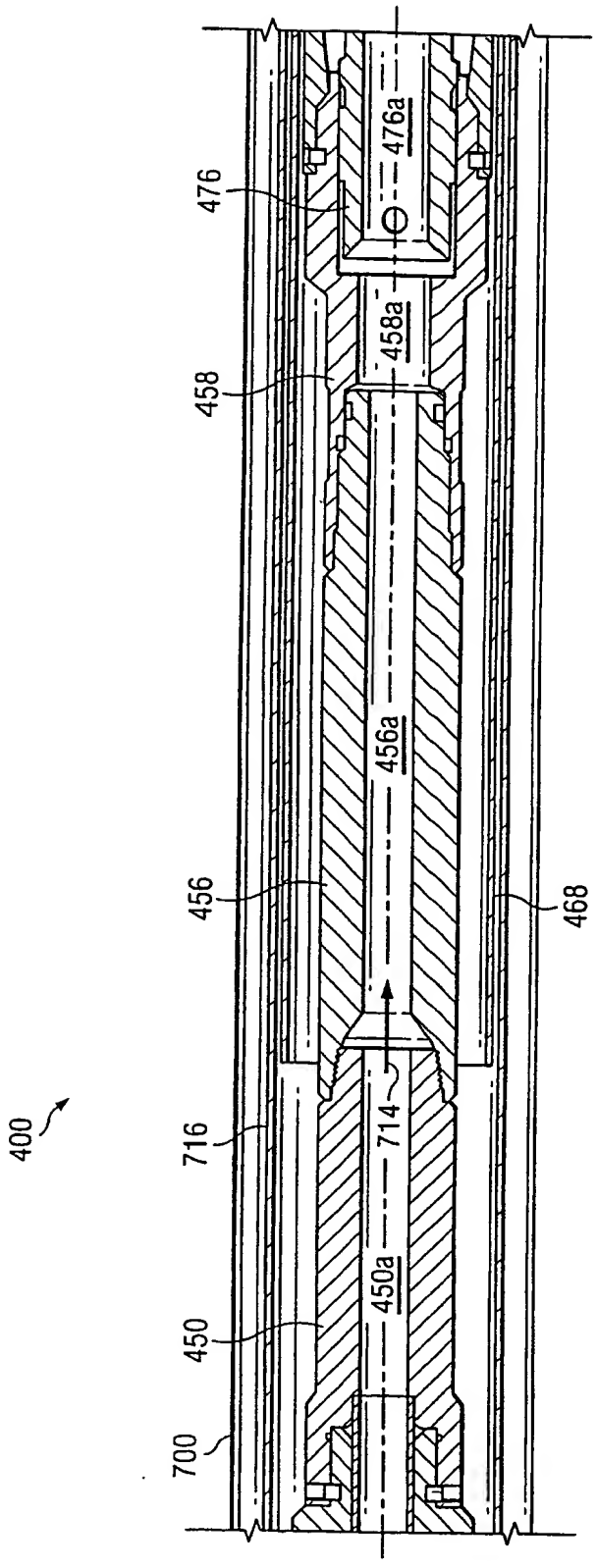
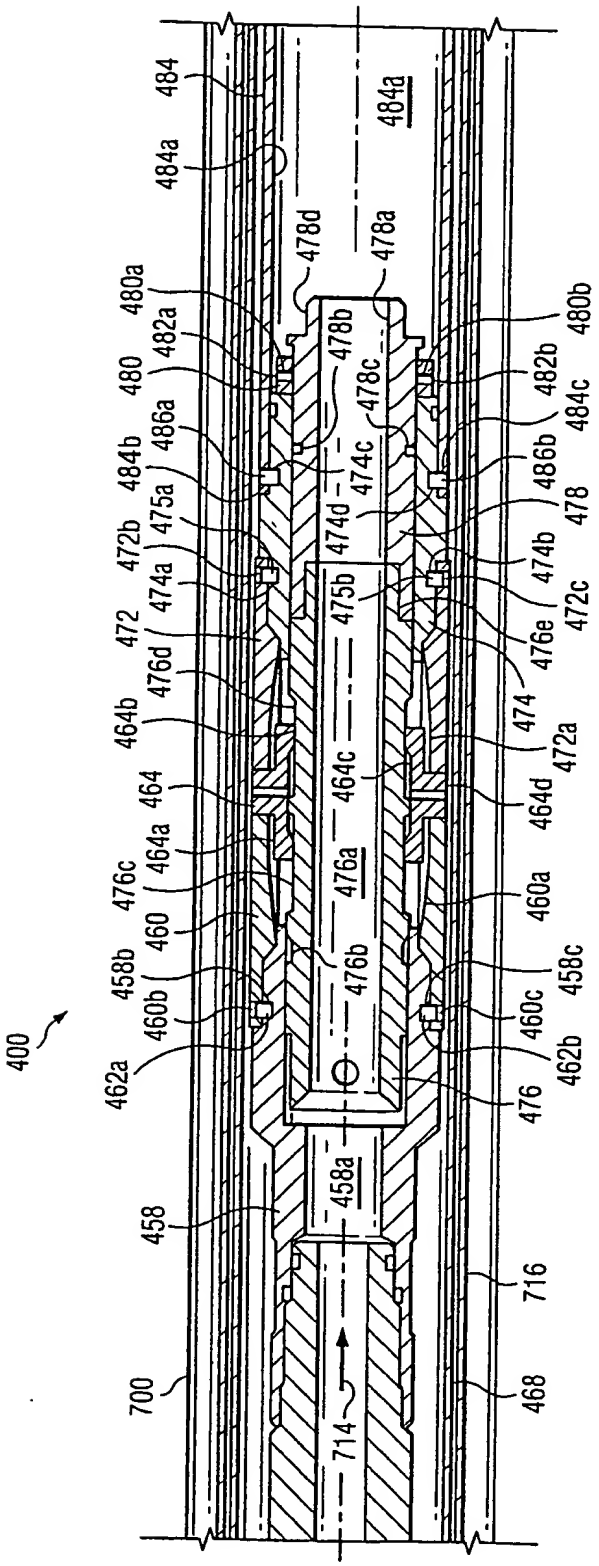


Fig. 34c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464b
476d
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472b
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480a
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484a
478d
478a
484a
480b
482b
484c
486b
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474b
472c
476e
474
472a
464d
460a
458c
460c
462b
476
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458a
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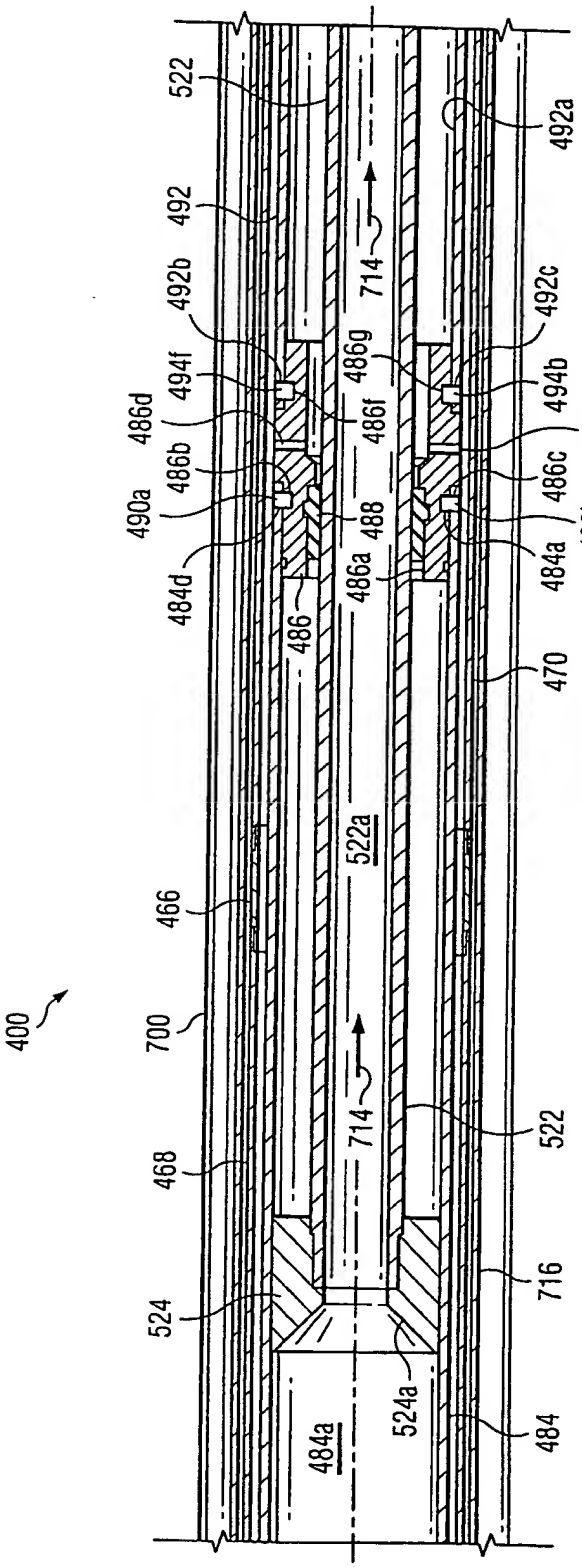
468
700
714
476b
476a
464c
475b
474d
474c
478b
478c

Fig. 34d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522
492
492b
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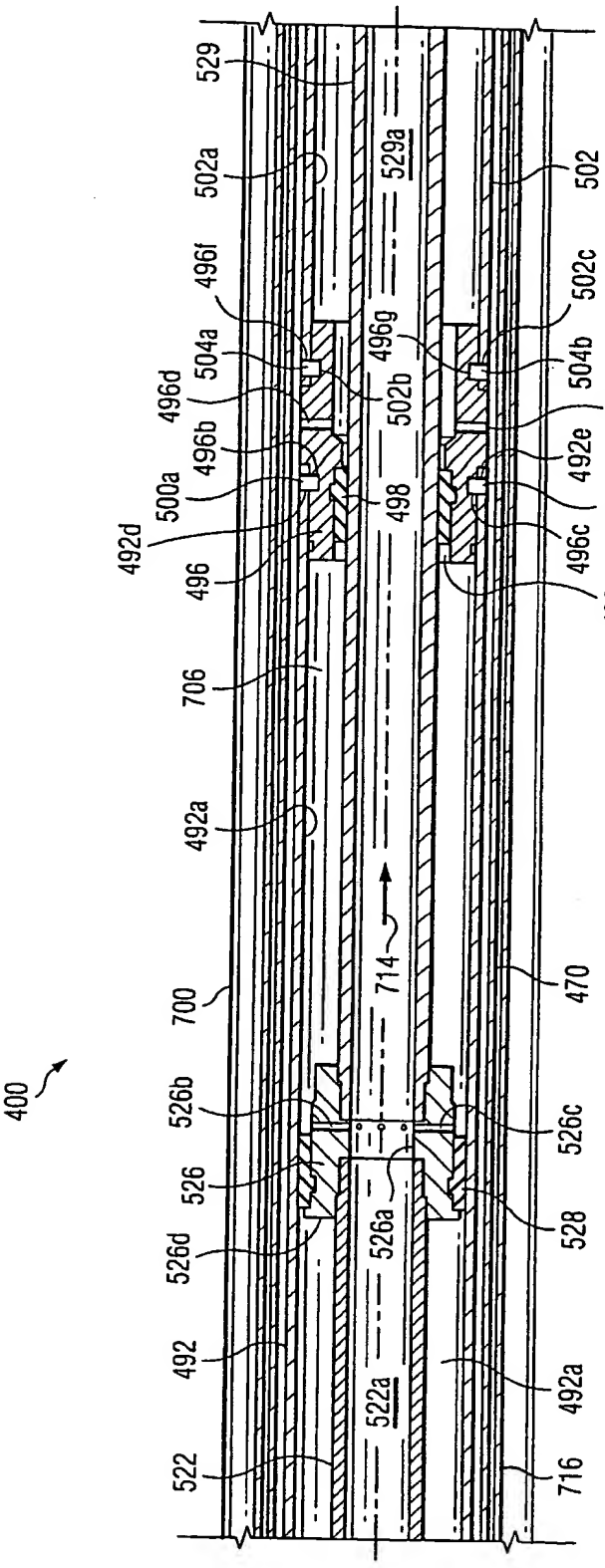
486d
486b
490a
484d
486
700
466
468
524
484a
524a
484
716
522
714
522a
470
490b
484a
486a
488
486f
486g
494b
492c
492a
486c
486e

Fig. 34e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496d
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496e
496b
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492d
496c
496
496a
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492a
714
700
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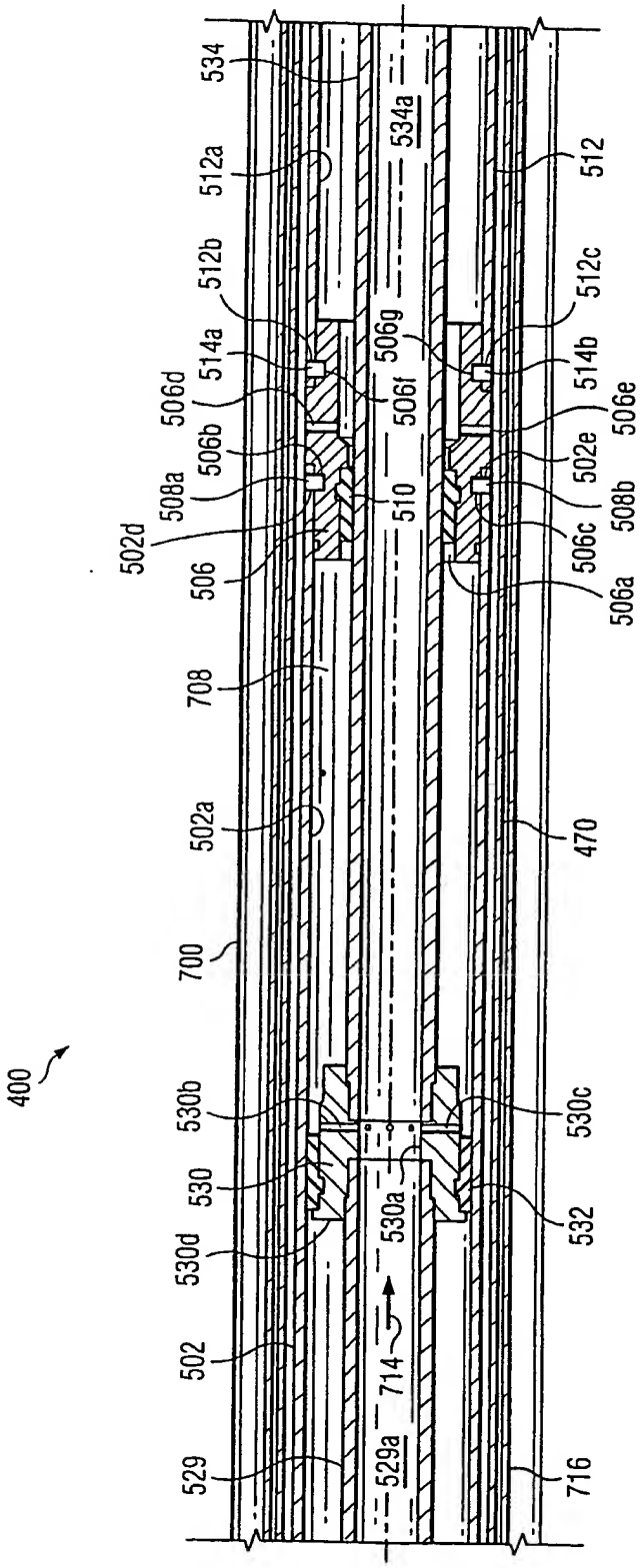
526b
526c
526
526a
528
526d
492
492a
522a
522
716

Fig. 34f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714
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530
530a
530b
700
502a
708
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502d
508a
506b
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514a
512b
512a
534
534a
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506g
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512c
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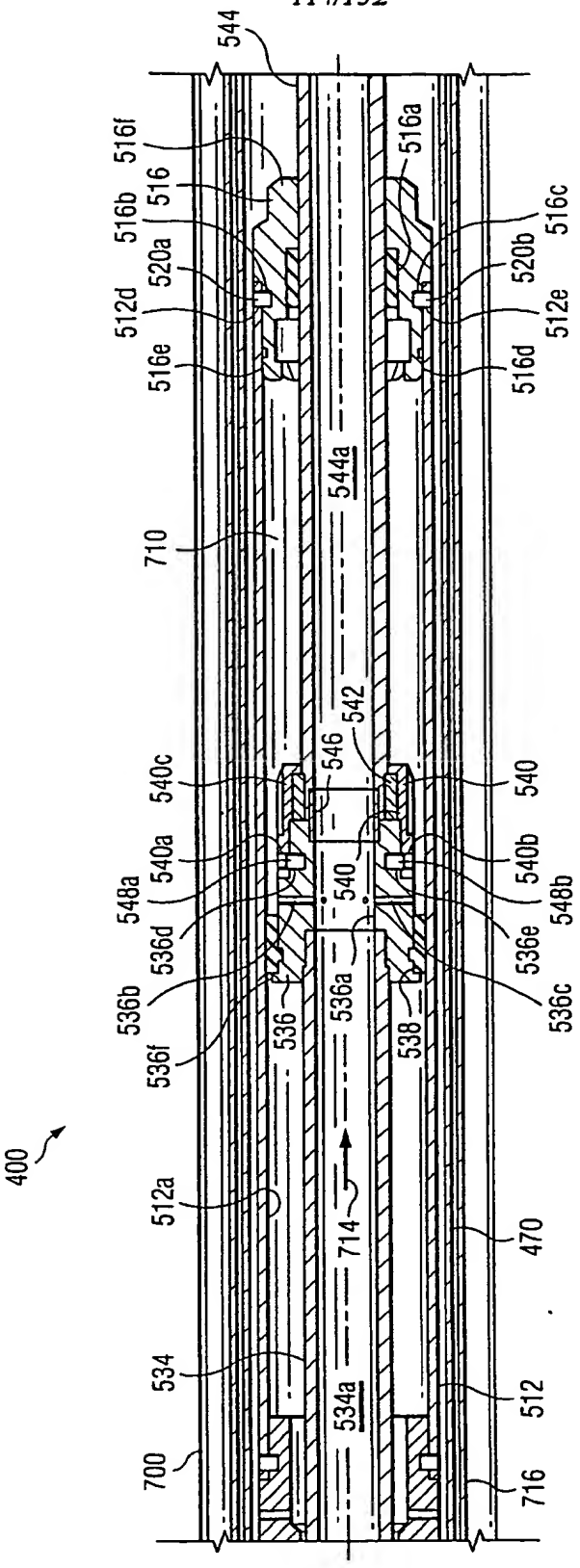
506e
502e
508b
506c
506a
470
532
530c
716

Fig. 34g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516d
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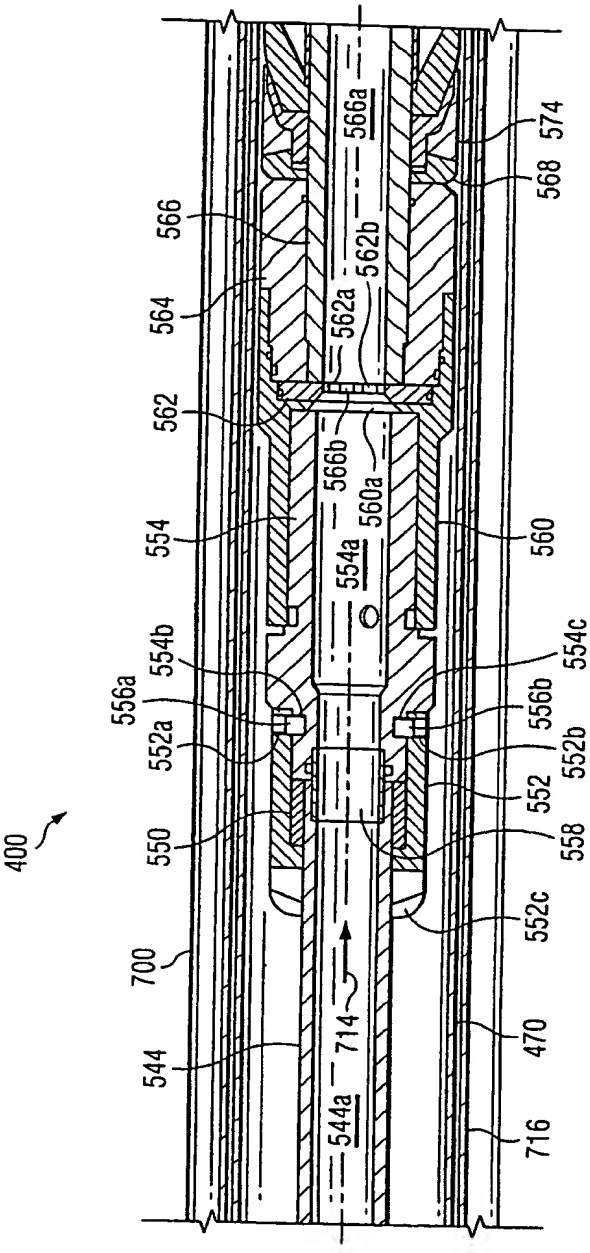
540a
540b
548a
536d
540
548b
536b
536e
536a
536f
536
538
536c
512a
714
470
534
512
534a
700
716

Fig. 34h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552a
552b
552c
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554a
554b
554c
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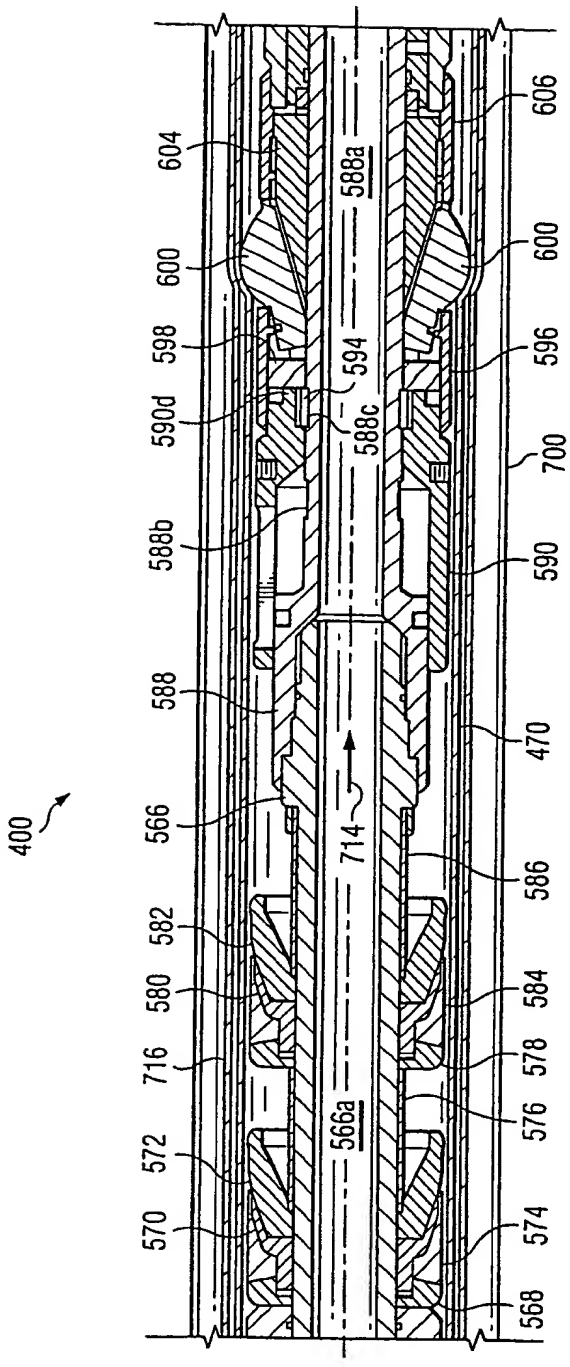
556b
558
560
560a
562
562a
562b
564
566
566a
566b
568
574

Fig. 34i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604
600
598
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588b
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582
580
716
572
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566a
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590
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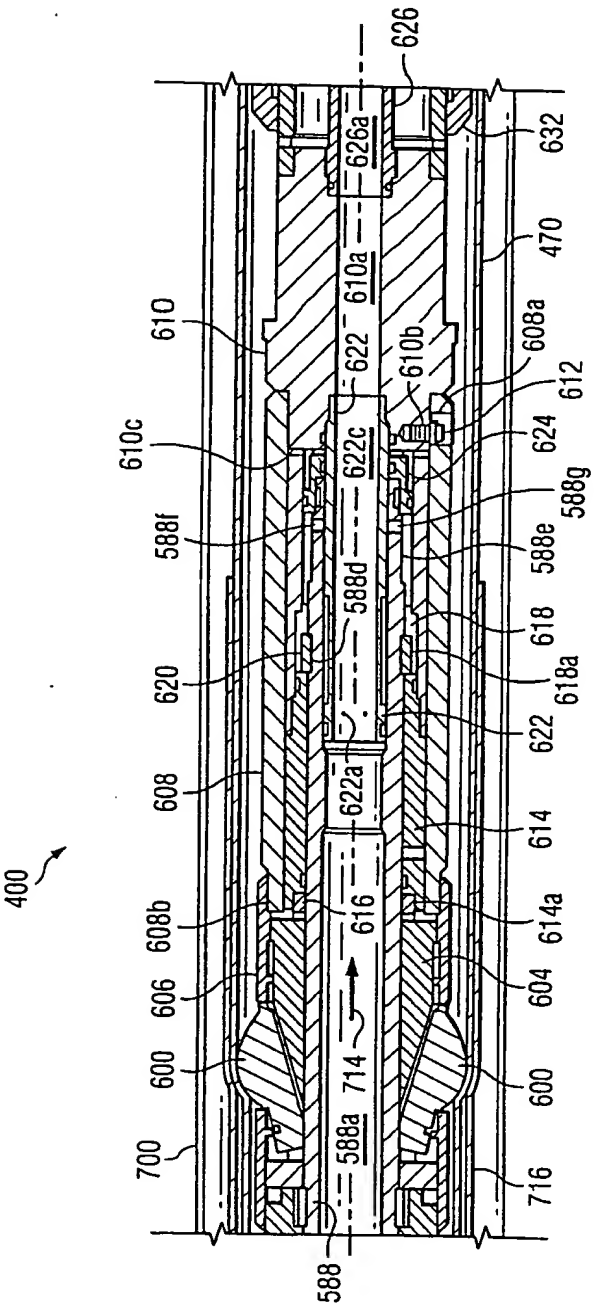
586
584
578
576
574
568

Fig. 34j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622
610b
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610c
622c
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588g
588f
588d
588e
618
620
618a
622
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622a
614
608b
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614a
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604
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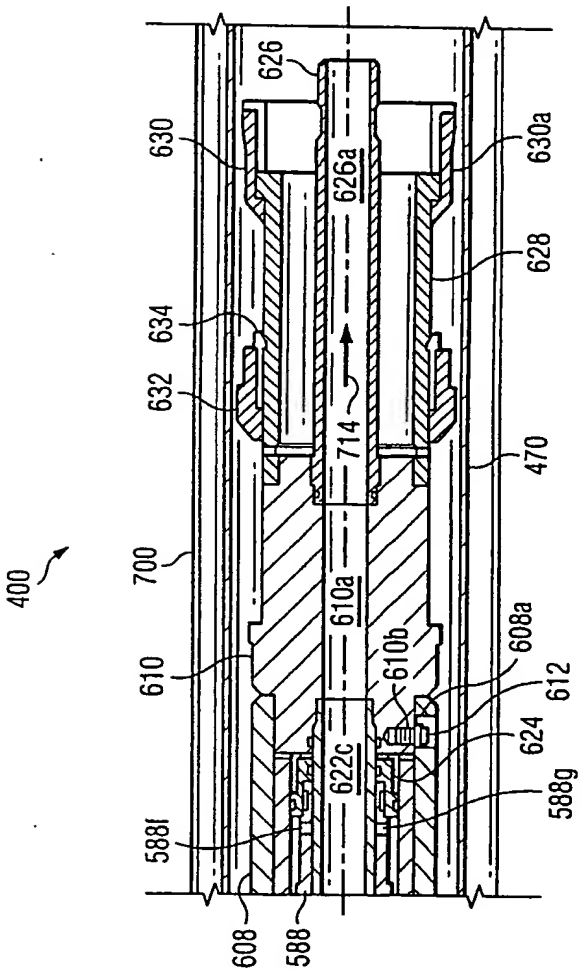
714
600
700
588a
716
588

Fig. 34k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626a
630a
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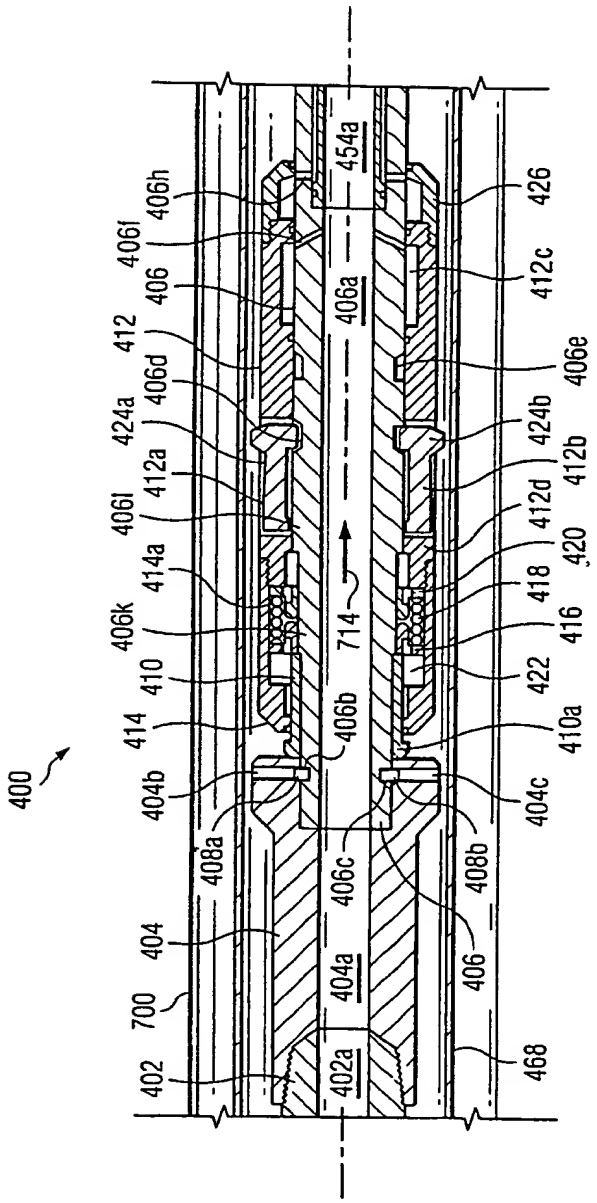
634
632
714
470

Fig. 341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406b
406c
714
404a
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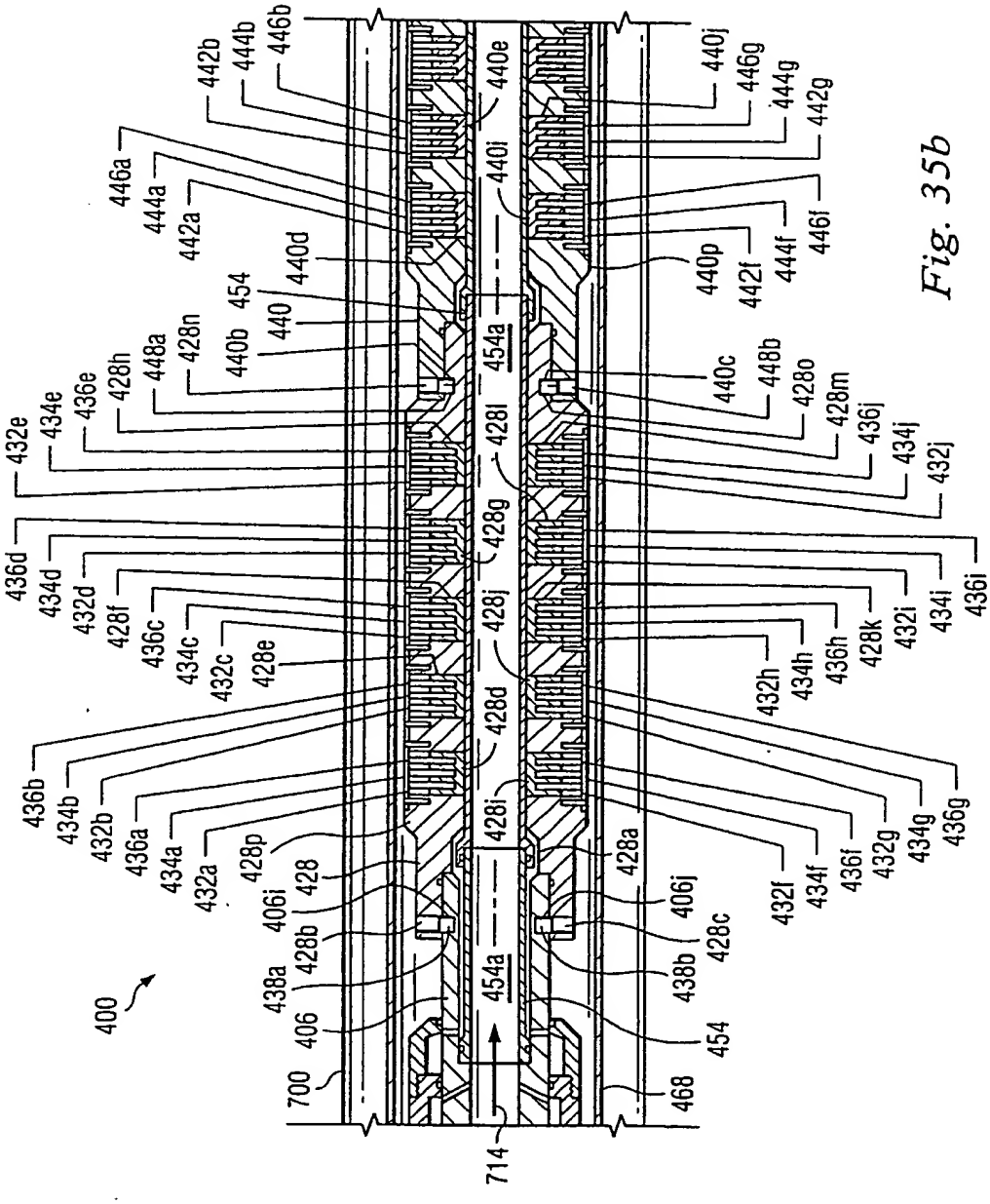
Fig. 35a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434e
436e
428h
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428n
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440d
442a
444a
446a
442b
444b
446b
440e
440i
454a
428g
428j
428d
428i
454a
406j
428a
438b
428c
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454a
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442f
444f
446f
440j
446g
444g
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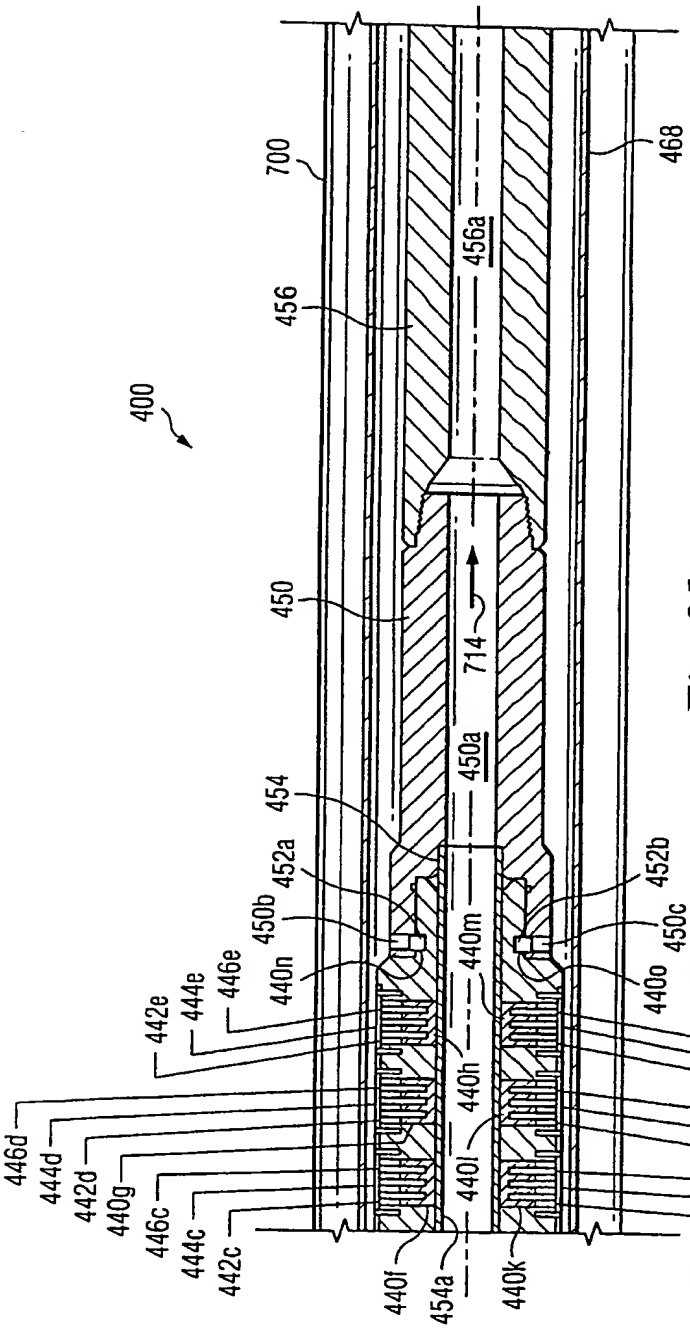
436g

Fig. 35b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444j
442j
440h
440l
446d
444d
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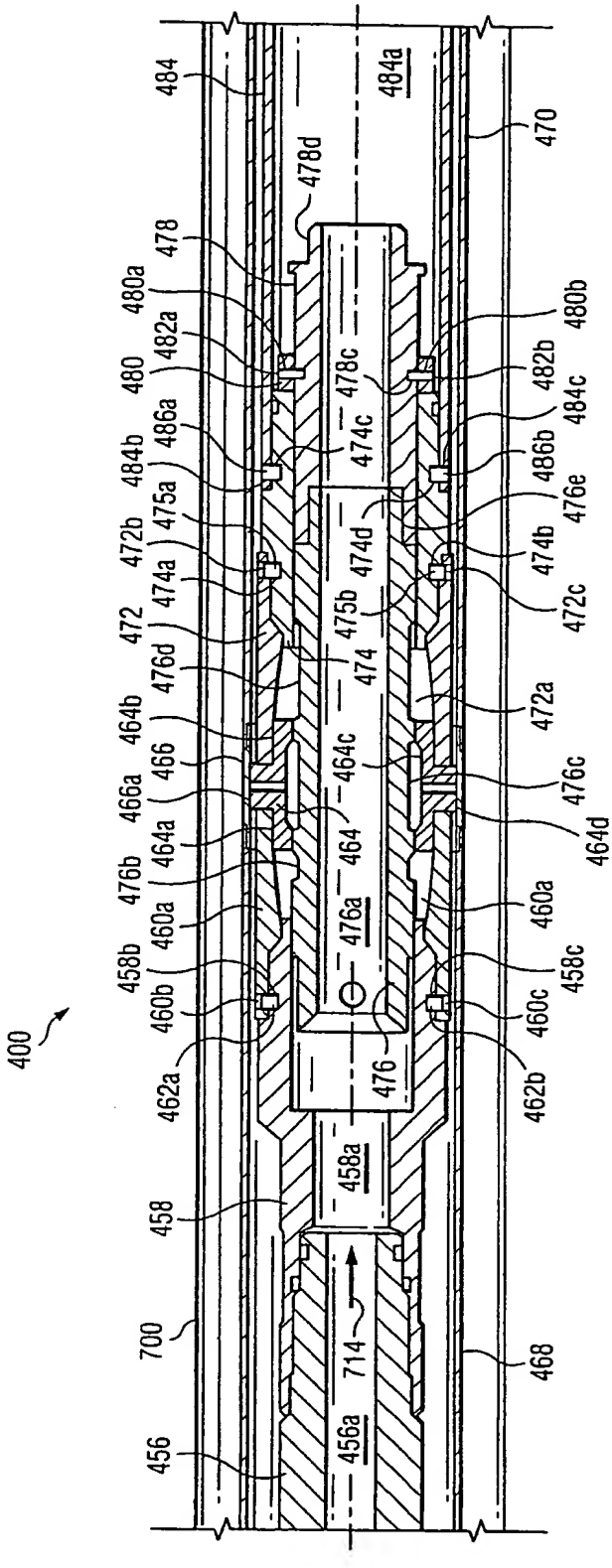
444h
446h
442i
444i
446i

Fig. 35c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478
478d
484
484a
470
468
714
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484c
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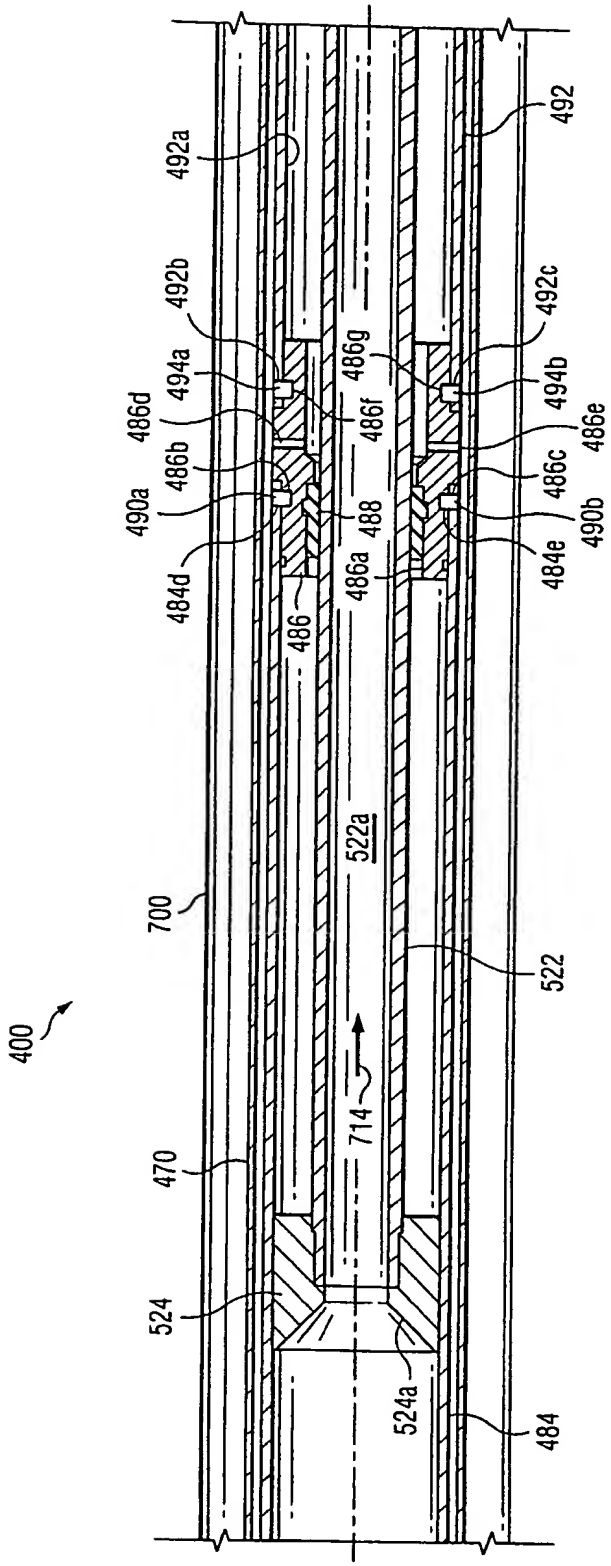
Fig. 35d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522a
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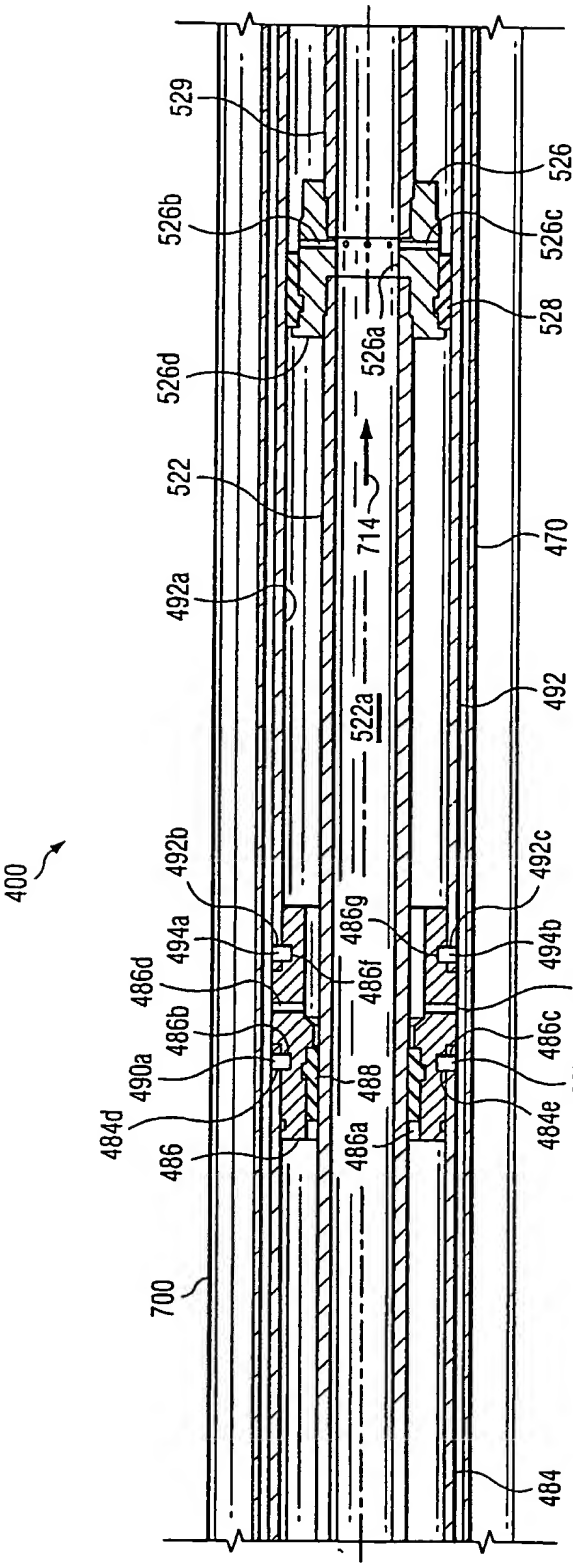
492c
494b
486e
486c
490b
484e

Fig. 35e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526a
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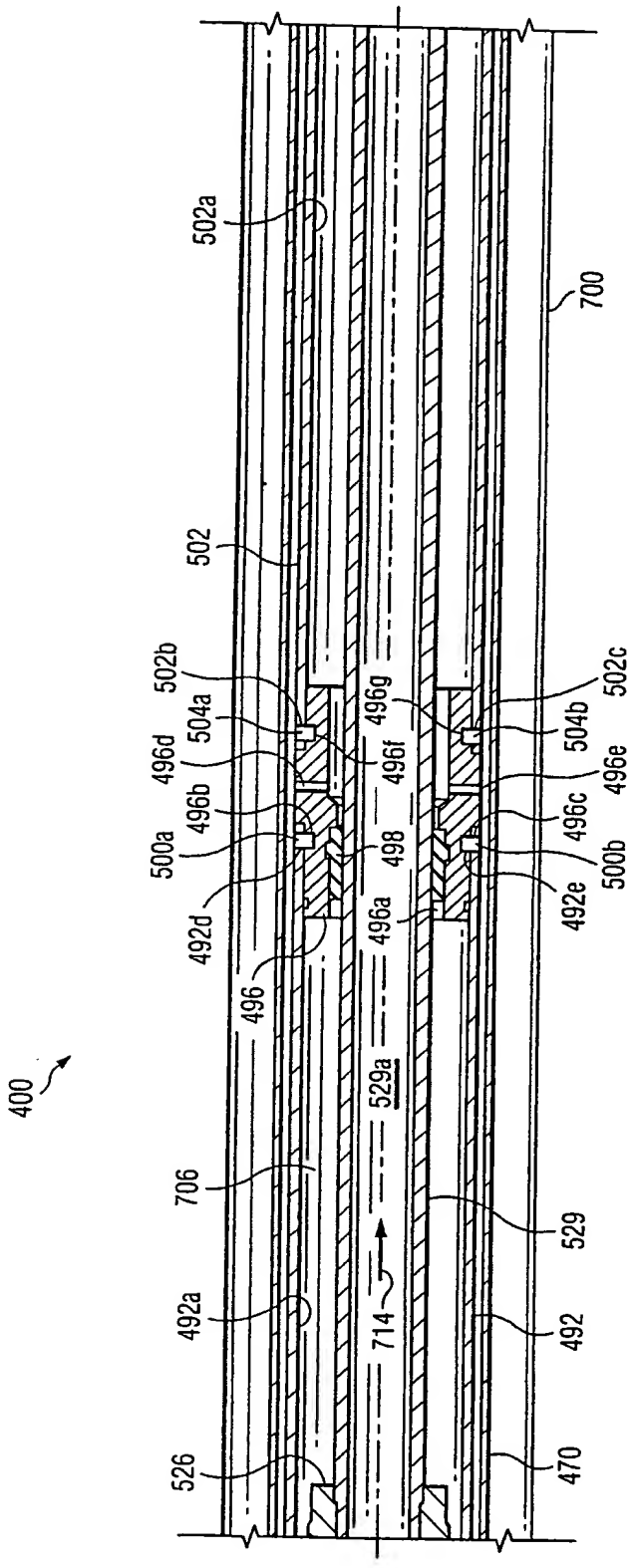
490b
484e
484
486g
486f
488
486a

Fig. 35f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496c
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492e
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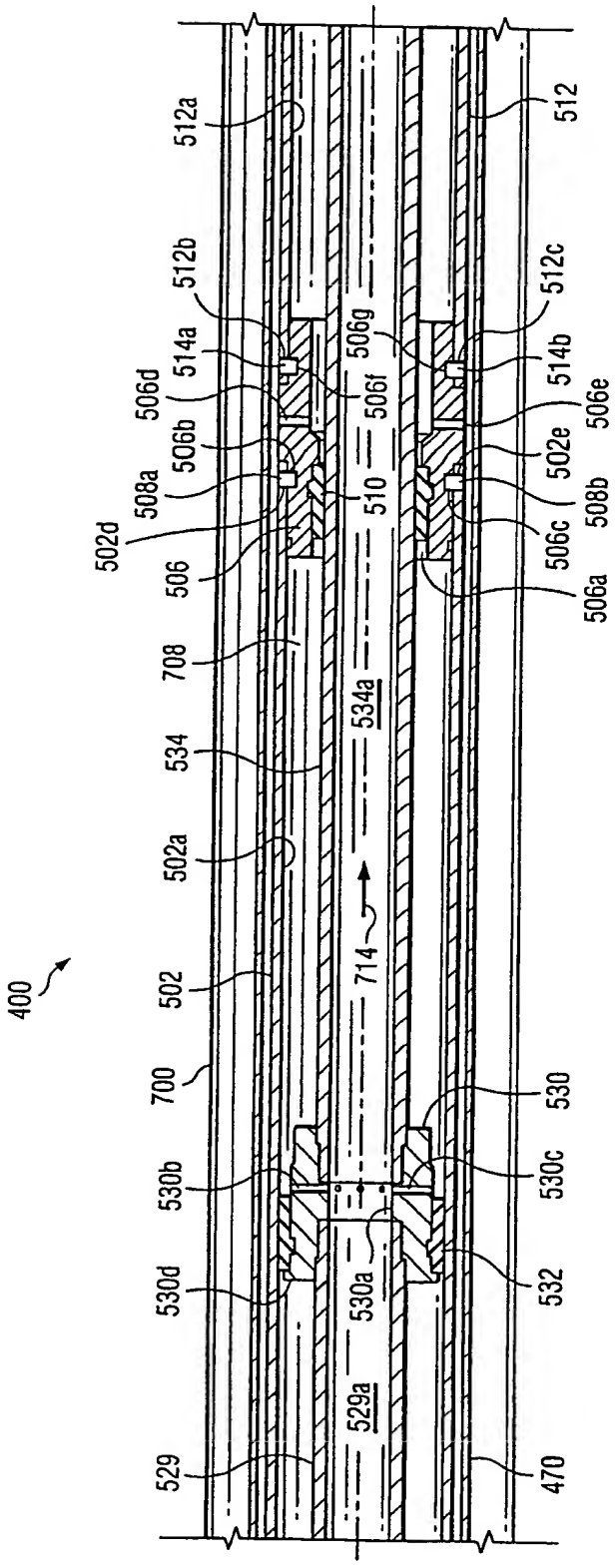
470
714

Fig. 35g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700
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530d
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529a
530a
534a
714
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506a
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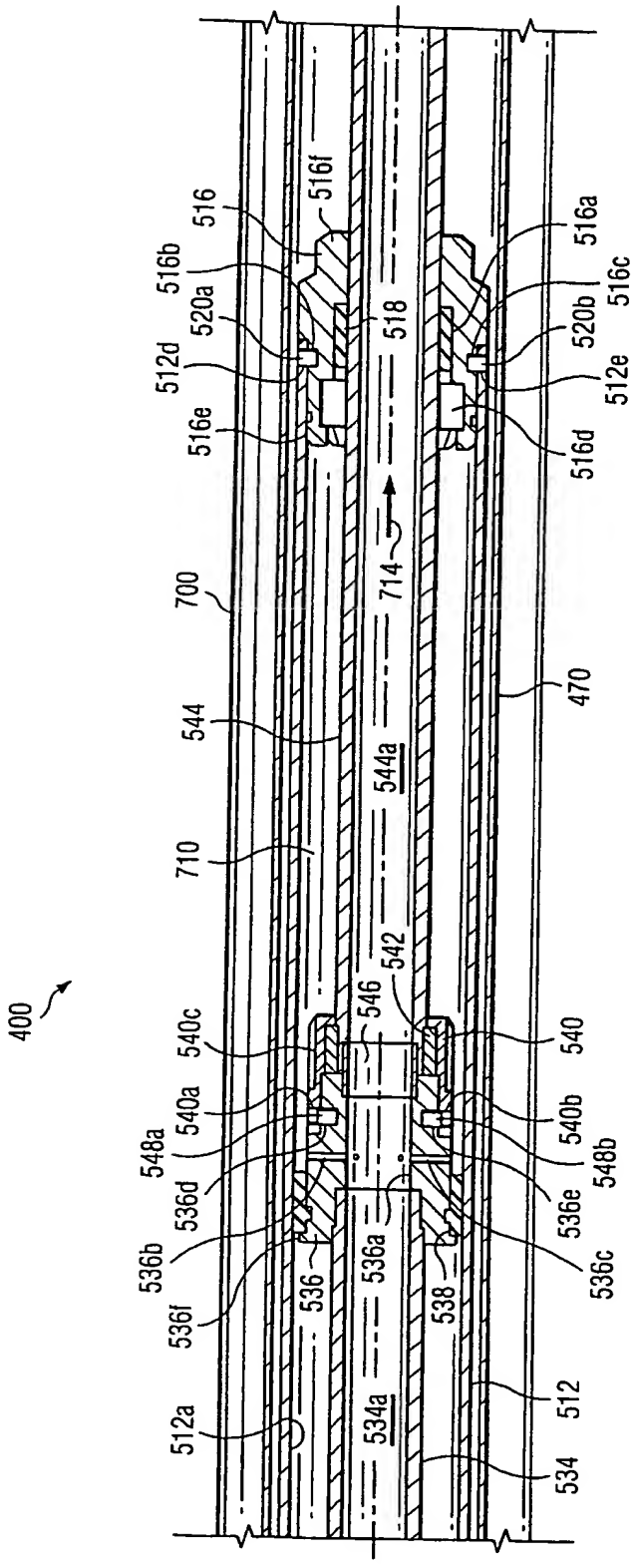
530c
532
470

Fig. 35h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542
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516f
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516b
520a
512d
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536c
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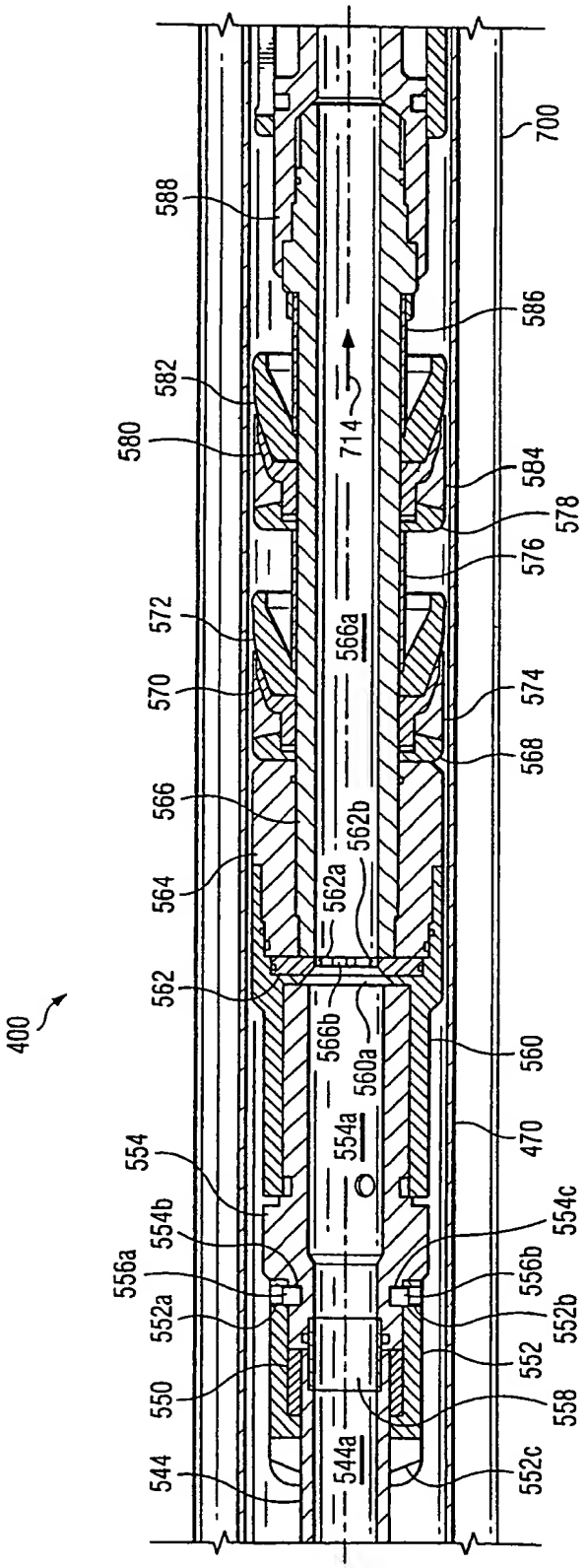
536a

Fig. 35i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566a
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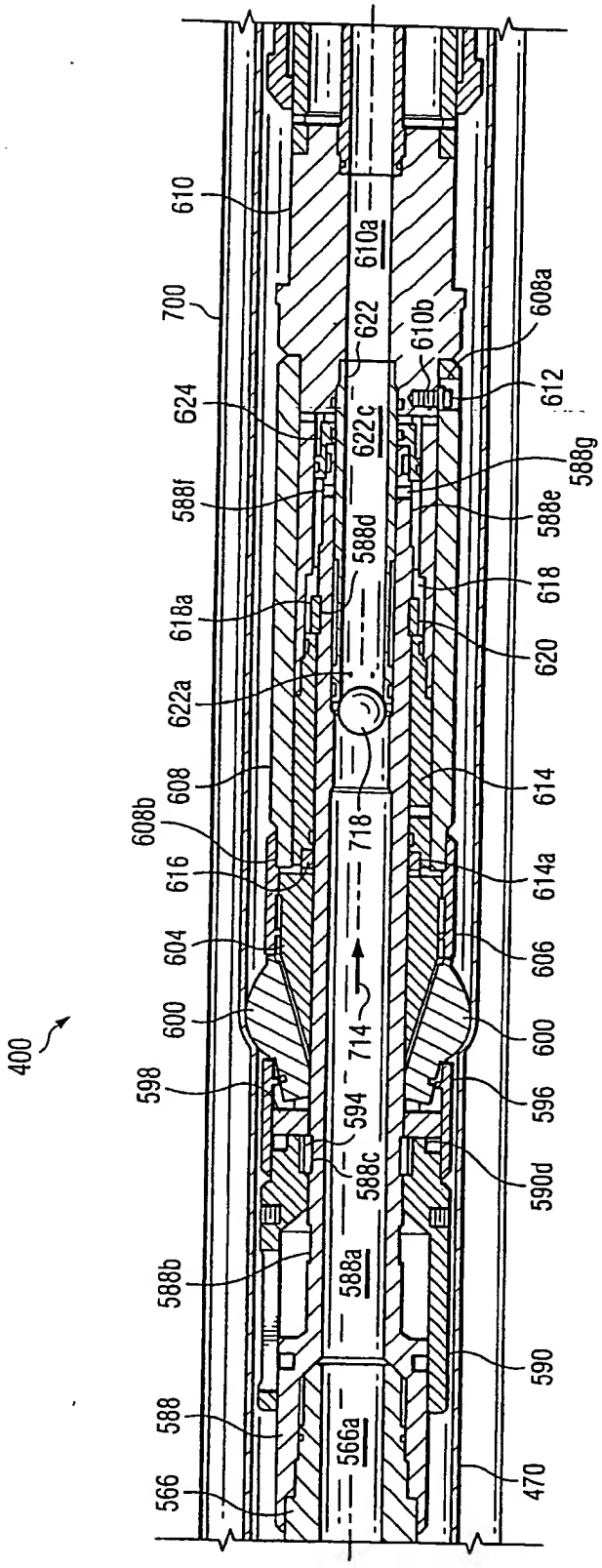
588
700
714
470
552
552b

Fig. 35j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622c
588g
588e
588d
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614a
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470
718
714
594
588c
588a
566a

Fig. 35k

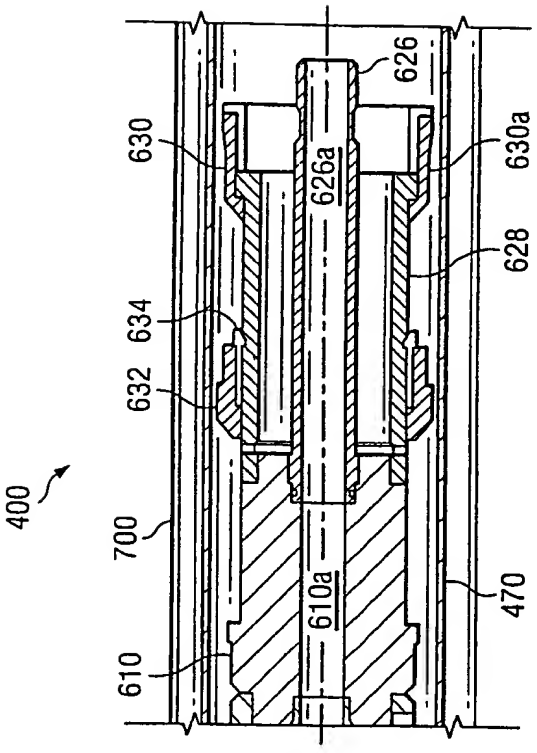
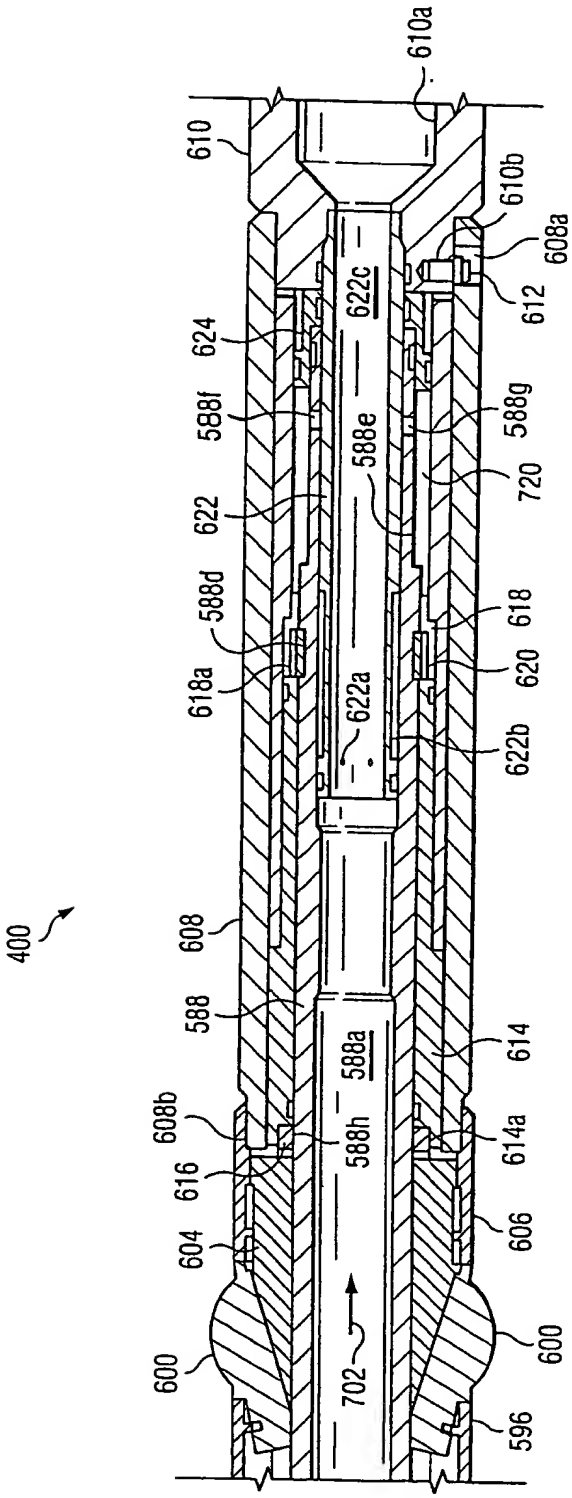


Fig. 351


400
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588d
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616
606
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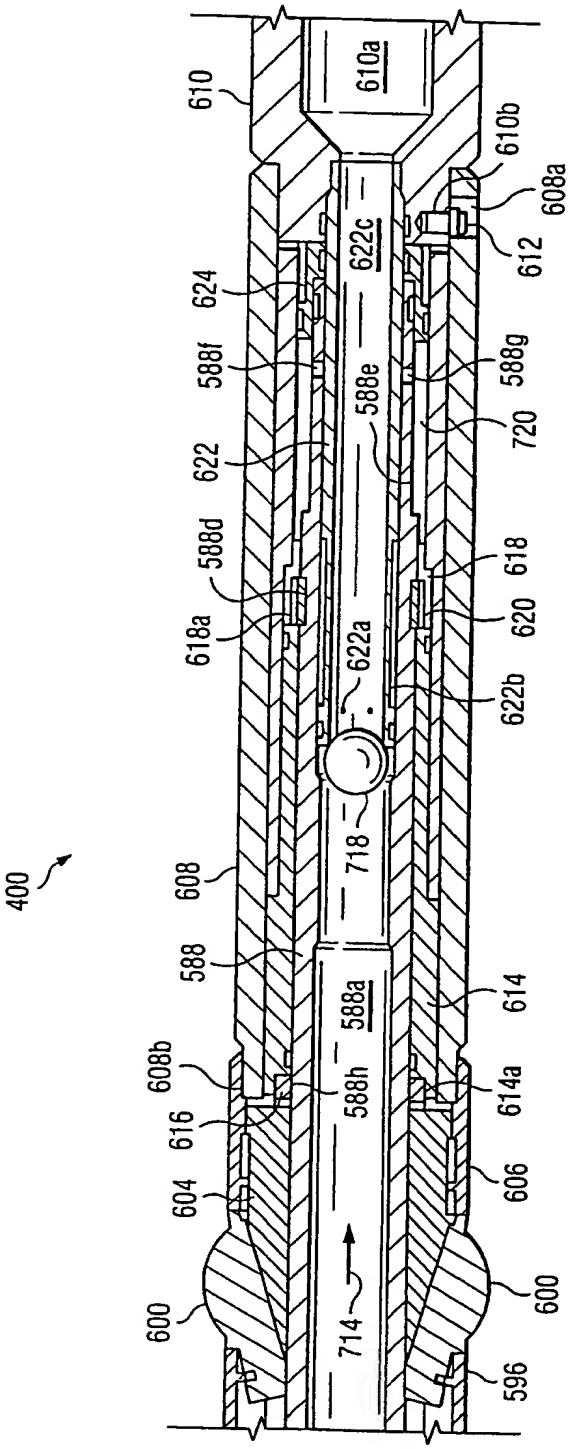
702
600
596

Fig. 36a


400
610
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720
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588d
618
618a
620
622a
622b
718
608
588
588a
614
608b
588h
614a
616
604
606
600
714
596

Fig. 36b

MONO DIAMETER WELLBORE CASING

Cross Reference To Related Applications

The present application claims the benefit of the filing dates of (1) U.S. provisional patent application serial no. 60/338,996, attorney docket no. 25791.87, filed on 11/12/2001, (2) U S. provisional patent application serial no. 60/339,013, attorney docket no 88, filed on 11/12/01 (3) U.S. provisional patent application serial no. 60/363,829, attorney docket no. 25791.95, filed on 3/13/2002, (4) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002 the disclosures of which are incorporated herein by reference.

The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney

docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/318,021, attorney docket no. 25791.58, filed on 9/7/2001, (29) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (30) U.S. provisional patent application serial no. 60/326,886, attorney docket no. 25791 60, filed on 10/3/2001, (31) U.S. utility patent application serial no. 09/96[illegible]922, attorney docket no. 25791.69, filed on 10/3/2·01, (32) U.S. provisional patent application serial no. 60/338,996, attorney docket no. 25791.87, filed on 11/12/2001, (33) U.S. provisional patent application serial no. 60/339,013, attorney docket no. 25791.88, filed on 11/12/2001, (34) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001, (35) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001, (36) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002, (37) U.S. provisional patent application serial no. 60/357,372, attorney docket no. 25791.71, filed on 2/15/2002, (38) U.S. provisional patent application serial no. 60/363,829, attorney docket no. 25791.95, filed on 3/13/2002, (39) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002, (40) U.S. provisional patent application serial no. 60/372,632, attorney docket no. 25791.101, filed on 4/15/2002, (41) U S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, (42) U.S. provisional patent application serial no. 60/383,917, attorney docket no. 25791.89, filed on 5/29/2002, (43) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002,

(44) U S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, (45) U.S. provisional patent application serial no. 60/391,703, attorney docket no 25791.90, filed on 6/26/2002, (46) U.S. provisional patent application serial no. 60/397,284, attorney docket no. 25791.106, filed on 7/19/2002, (47) U.S. provisional patent application serial no. 60/398,061, attorney docket no. 25791.110, filed on 7/24/2002, (48) U.S. provisional patent application serial no. 60/399,240, attorney docket no. 25791.111, filed on 7/29/2002, (49) U.S provisional patent application serial no, 60/405,610, attorney docket no. 25791.119, filed on 8/23/2002, (50) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/2002, (51) U.S. provisional patent application serial no. 60/407,442, attorney docket no. 25791.125, filed on 8/30/2002, (52) U.S. provisional patent application serial no. 60/412,542, attorney docket no. 25791.102, filed on 9/20/2002, (53) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/2002, (54) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791 118, filed on 9/20/2002, (55) U.S. provisional patent application serial no 60/412,544, attorney docket no. 25791.121, filed on 9/20/2002, (56) U.S. provisional patent application serial no. 60/412,187· attorney docket no. 25791.128, filed on 9/20/2002, (57) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.127, filed on 9/20/2002, (58) U.S. provisional patent application serial no. 60/412,487, attorney docket no 25791.127, filed on 9/20/2002, (58) U.S. provisional patent application serial no. 60/412,487, attorney docket no. 25791.112, filed on 9/20/2002, (59) U.S. provisional patent application serial no. 60/412,488, attorney docket no. 25791.114, filed on 9/20/2002, and (60) U.S. provisional patent application serial no. 60/412,371, attorney docket no. 25791.129, filed on 9/20/2002, (61) PCT Patent Application No. PCT/US02_____, attorney docket no. 25791.87.02, filed on 11/11/02 and (62) PCT Patent Application No. PCT/US02_____, attorney docket no. 25791.88.02, filed on 11/11/02 the disclosures of which are incorporated herein by reference.

Background Of The Invention

This invention relates generally to oil and gas exploration, and in particular to forming and repairing wellbore casings to facilitate oil and gas exploration.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming and/or repairing wellbore casings.

Summary of the Invention

According to one aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a float shoe adapted to mate with an end of the expandable tubular member, an adjustable expansion mandrel coupled to the float shoe adapted to be controllably expanded to a larger outside dimension for radial expansion of the expandable tubular member or collapsed to a smaller outside dimension, an actuator coupled to the adjustable expansion mandrel adapted to controllably displace the adjustable expansion mandrel relative to the expandable tubular member, a locking device coupled to the actuator adapted to controllably engage the expandable tubular member, and a support member coupled to the locking device.

According to another aspect of the present invention, a method for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes positioning an adjustable expansion mandrel within the expandable tubular member, supporting the expandable tubular member and the adjustable expansion mandrel within the borehole, lowering the adjustable expansion mandrel out of the expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, and displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member.

According to another aspect of the present invention, a method for forming a mono diameter wellbore casing is provided that includes positioning an adjustable expansion mandrel within a first expandable tubular member, supporting the first expandable tubular member and the adjustable expansion mandrel within a borehole, lowering the adjustable expansion mandrel out of the first expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, displacing the adjustable expansion mandrel upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole, positioning the adjustable expansion mandrel within a second expandable tubular member, supporting the second expandable tubular member and the adjustable expansion mandrel within the borehole in overlapping relation to the first expandable tubular member, lowering the adjustable expansion mandrel out of the second expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, and displacing the adjustable expansion mandrel upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole.

According to another aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a float shoe adapted to mate with an end of the expandable tubular member, an adjustable expansion mandrel coupled to the float shoe adapted to be controllably expanded to a larger outside dimension for radial expansion of the expandable tubular

member or collapsed to a smaller outside dimension, an actuator coupled to the adjustable expansion mandrel adapted to controllably displace the adjustable expansion mandrel relative to the expandable tubular member, a locking device coupled to the actuator adapted to controllably engage the expandable tubular member, a support member coupled to the locking device, and a sealing member for sealingly engaging the expandable tubular member adapted to define a pressure chamber above the adjustable expansion mandrel during radial expansion of the expandable tubular member.

According to another aspect of the present invention, a method for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes positioning an adjustable expansion mandrel within the expandable tubular member, supporting the expandable tubular member and the adjustable expansion mandrel within the borehole, lowering the adjustable expansion mandrel out of the expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member within the borehole, and pressurizing an interior region of the expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the expandable tubular member within the borehole.

According to another aspect of the present invention, a method for forming a mono diameter wellbore casing is provided that includes positioning an adjustable expansion mandrel within a first expandable tubular member, supporting the first expandable tubular member and the adjustable expansion mandrel within a borehole, lowering the adjustable expansion mandrel out of the first expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, displacing the adjustable expansion mandrel upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole, pressurizing an interior region of the first expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the first expandable tubular member within the borehole, positioning the adjustable expansion mandrel within a second expandable tubular

member, supporting the second expandable tubular member and the adjustable expansion mandrel within the borehole in overlapping relation to the first expandable tubular member, lowering the adjustable expansion mandrel out of the second expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, displacing the adjustable expansion mandrel upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole, and pressurizing an interior region of the second expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the second expandable tubular member within the borehole.

According to another aspect of the present invention, an apparatus for drilling a borehole within a subterranean formation and then radially expanding and plastically deforming an expandable tubular member within the drilled borehole is provided that includes a float shoe adapted to mate with an end of the expandable tubular member, a drilling member coupled to the float shoe adapted to drill the borehole, an adjustable expansion mandrel coupled to the float shoe adapted to be controllably expanded to a larger outside dimension for radial expansion of the expandable tubular member or collapsed to a smaller outside dimension, an actuator coupled to the adjustable expansion mandrel adapted to controllably displace the adjustable expansion mandrel relative to the expandable tubular member, a locking device coupled to the actuator adapted to controllably engage the expandable tubular member, and a support member coupled to the locking device.

According to another aspect of the present invention, a method for drilling a borehole within a subterranean formation and then radially expanding and plastically deforming an expandable tubular member within the drilled borehole is provided that include positioning an adjustable expansion mandrel within the expandable tubular member, coupling a drilling member to an end of the expandable tubular member, drilling the borehole using the drilling member, positioning the adjustable expansion mandrel and the expandable tubular member within the drilled borehole, lowering the adjustable expansion mandrel out of the expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, and displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to

radially expand and plastically deform n portions of the expandable tubular member within the drilled borehole.

According to another aspect of the present invention, a method for forming a mono diameter wellbore casing within a borehole is provided that includes positioning an adjustable expansion mandrel within a first expandable tubular member, coupling a drilling member to an end of the first expandable tubular member, drilling a first section of the borehole using the drilling member, supporting the first expandable tubular member and the adjustable expansion mandrel within the drilled first section of the borehole, lowering the adjustable expansion mandrel out of the first expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, displacing the adjustable expansion mandrel upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the drilled first section of the borehole, positioning the adjustable expansion mandrel within a second expandable tubular member, coupling the drilling member to an end of the second expandable tubular member, drilling a second section of the borehole using the drilling member, supporting the second expandable tubular member and the adjustable expansion mandrel within the borehole in overlapping relation to the first expandable tubular member within the second drilled section of the borehole, lowering the adjustable expansion mandrel out of the second expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, and displacing the adjustable expansion mandrel upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the drilled second section of the borehole.

According to another aspect of the present invention, an apparatus for drilling a borehole within a subterranean formation and then radially expanding and plastically deforming an expandable tubular member within the drilled borehole is provided that includes a float shoe adapted to mate with an end of the expandable tubular member, a drilling member coupled to the float shoe adapted to drill the borehole, an adjustable expansion mandrel coupled to the float shoe adapted to be controllably expanded to a larger outside dimension for radial expansion of the expandable tubular member or collapsed to a smaller outside dimension, an actuator coupled to the adjustable

expansion mandrel adapted to controllably displace the adjustable expansion mandrel relative to the expandable tubular member, a locking device coupled to the actuator adapted to controllably engage the expandable tubular member, a support member coupled to the locking device, and a sealing member for sealing engaging the expandable tubular member adapted to define a pressure chamber above the adjustable expansion mandrel during the radial expansion of the expandable tubular member.

According to another aspect of the present invention, a method for drilling a borehole within a subterranean formation and then radially expanding and plastically deforming an expandable tubular member within the drilled borehole is provided that includes positioning an adjustable expansion mandrel within the expandable tubular member, coupling a drilling member to an end of the expandable tubular member, drilling the borehole using the drilling member, positioning the adjustable expansion mandrel and the expandable tubular member within the drilled borehole, lowering the adjustable expansion mandrel out of the expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member within the drilled borehole, and pressuring an interior portion of the expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the expandable tubular member within the drilled borehole.

According to another aspect of the present invention, a method for forming a mono diameter wellbore casing within a borehole is provided that includes positioning an adjustable expansion mandrel within a first expandable tubular member, coupling a drilling member to an end of the first expandable tubular member, drilling a first section of the borehole using the drilling member, supporting the first expandable tubular member and the adjustable expansion mandrel within the drilled first section of the borehole, lowering the adjustable expansion mandrel out of the first expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, displacing the adjustable expansion mandrel upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the drilled first section of the borehole, pressuring

an interior portion of the first expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the first expandable tubular member within the first drilled section of the borehole, positioning the adjustable expansion mandrel within a second expandable tubular member, coupling the drilling member to an end of the second expandable tubular member, drilling a second section of the borehole using the drilling member, supporting the second expandable tubular member and the adjustable expansion mandrel within the borehole in overlapping relation to the first expandable tubular member within the second drilled section of the borehole, lowering the adjustable expansion mandrel out of the second expandable tubular member, increasing the outside dimension of the adjustable expansion mandrel, displacing the adjustable expansion mandrel upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the drilled second section of the borehole, and pressuring an interior portion of the second expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the second expandable tubular member within the drilled second section of the borehole.

According to another aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a float shoe adapted to mate with an end of the expandable tubular member, a first adjustable expansion mandrel coupled to the float shoe adapted to be controllably expanded to a first larger outside dimension for radial expansion of the expandable tubular member or collapsed to a first smaller outside dimension, a second adjustable expansion mandrel coupled to the first adjustable expansion mandrel adapted to be controllably expanded to a second larger outside dimension for radial expansion of the expandable tubular member or collapsed to a second smaller outside dimension, an actuator coupled to the first and second adjustable expansion mandrels adapted to controllably displace the first and second adjustable expansion mandrels relative to the expandable tubular member, a locking device coupled to the actuator adapted to controllably engage the expandable tubular member, and a support member coupled to the locking device. The first larger outside dimension of the first adjustable expansion mandrel is larger than the second larger outside dimension of the second adjustable expansion mandrel.

According to another aspect of the present invention, a method for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes positioning first and second adjustable expansion mandrels within the expandable tubular member, supporting the expandable tubular member and the first and second adjustable expansion mandrels within the borehole, lowering the first adjustable expansion mandrel out of the expandable tubular member, increasing the outside dimension of the first adjustable expansion mandrel, displacing the first adjustable expansion mandrel upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member, displacing the first adjustable expansion mandrel and the second adjustable expansion mandrel downwardly relative to the expandable tubular member, decreasing the outside dimension of the first adjustable expansion mandrel and increasing the outside dimension of the second adjustable expansion mandrel, and displacing the second adjustable expansion mandrel upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of the expandable tubular member. The outside dimension of the first adjustable expansion mandrel is greater than the outside dimension of the second adjustable expansion mandrel.

According to another aspect of the present invention, a method for forming a mono diameter wellbore casing is provided that includes positioning first and second adjustable expansion mandrels within a first expandable tubular member, supporting the first expandable tubular member and the first and second adjustable expansion mandrels within a borehole, lowering the first adjustable expansion mandrel out of the first expandable tubular member, increasing the outside dimension of the first adjustable expansion mandrel, displacing the first adjustable expansion mandrel upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member, displacing the first adjustable expansion mandrel and the second adjustable expansion mandrel downwardly relative to the first expandable tubular member, decreasing the outside dimension of the first adjustable expansion mandrel and increasing the outside dimension of the second adjustable expansion mandrel, displacing the second adjustable expansion mandrel upwardly relative to the first expandable tubular member